

Chapter 4. Subwatershed Actions

This chapter contains descriptions of near-term actions in each of the five subwatersheds of WRIA 9. Each near-term action addresses one or more of the main WRIA 9 Strategy elements, or is a study that will provide necessary information about salmon and their habitat in WRIA 9. Symbols denote which Strategy elements each action addresses, as follows:



Indicates actions to protect habitat



Indicates actions to restore habitat



Indicates actions to connect habitats



Indicates studies.

In addition, each subwatershed section contains descriptions of projects that benefit chinook salmon and/or bull trout and are planned to occur in the next five years. Planned projects that benefit other species are listed in Appendix C. The letters A through D denote the current phase of planning for each project, as follows:



Indicates the concept and feasibility phase



Indicates project sponsors are identifying funding for the project



Indicates the project is in the engineering and design phase



Indicates the project is under construction or construction is pending.

Chapter 4 describes only projects that are already planned. WRIA-wide Action 15 sets up a process to evaluate these planned projects and to identify new projects to fill any gaps¹⁴.

¹⁴ It should be noted that landowner permission and appropriate permits are needed for all projects, including restoration projects. Information about the commonly required environmental permits is available from the Department of Ecology (Publication No. 90-29, 1998) and specific permit guidance is provided through Ecology's on-line permit assistance webpage: www.ecy.wa.gov/programs/sea/pac/index.html. The Ecology permit center also maintains a toll-free number: 1-800-917-0043.



Upper Green River Subwatershed

Background

The Upper Green River subwatershed contains the headwaters of the Green River, which is in the vicinity of Blowout Mountain and Snowshoe Butte, and represents about 45 percent of the Green River's watershed area and stream mileage. The river flows generally west and northwest from the Cascades through approximately 25 miles of steeply sloped, densely forested terrain with narrow valleys. Howard Hanson Dam is immediately below the confluence of the North Fork with the Green River at approximately RM 64.5. Completed in 1962, the dam provides up to 106,000 acre-feet of water storage at an elevation of 1,206 feet. Figure 4 is a map of the Upper Green River subwatershed.

The primary land use in the Upper Green River subwatershed is forestry (99 percent), and the upland vegetation is a patchwork of old growth, second growth, and recently logged areas (see Figure 5). Major forestry landowners include the U.S. Forest Service, Plum Creek Timber, Tacoma Public Utilities, Guistina Resources, Weyerhaeuser, and the Washington State Department of Natural Resources. Tacoma Public Utilities draws its water supply from the Upper Green River subwatershed and operates a well field along the North Fork.

Fish Use

The Tacoma diversion dam and Howard Hanson Dam completely block anadromous fish passage to the Upper Green River subwatershed. Resident cutthroat, rainbow, and brook trout use the Upper Green River subwatershed for every stage of their life history. The Washington State Department of Fish and Wildlife and the Muckleshoot Indian Tribe have planted juvenile chinook salmon, coho salmon, and steelhead trout in the Upper Green River subwatershed. The Washington State Department of Fish and Wildlife transported wild winter steelhead adults around the two dams from 1992 through 2000. The juveniles use the subwatershed for rearing and the adults use it for spawning. Bull trout have not been documented in the Upper Green River subwatershed.

Factors of Decline and Strategy

The two dams completely block upstream fish passage to the Upper Green River and severely hamper downstream passage of juveniles to the rest of the watershed. However, the fish that do reside in the Upper Green River face other habitat problems, primarily as a result of poor past forestry practices, including reduction and degradation of riparian functions and large woody debris, limited channel migration, and limited creation of new habitat. Also, the reservoir pool reduces spawning habitat and riparian function due to its periodic inundation of 4.5 miles of the mainstem and 3.0 miles of tributaries. The inundation also delays juvenile out-migration due to the increased depth of and reduced current in the pool. In the tributaries, logging practices have resulted in loss of riparian functions and large woody debris, fish passage barriers, excessive sedimentation, decreased water quality, and altered stream hydrology.

Figure 4. Upper Green River Subwatershed

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Figure 5. Forestry, Agriculture, and Major Landowners: WRIA 9.

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The WRIA 9 Strategy identifies restoring fish access to the Upper Green River subwatershed as a high priority goal for the WRIA. The subwatershed may be large enough to act as refugia for salmon, able to seed downstream areas once appropriate access and habitat have been established. In addition, the Strategy recommends protection of currently functioning habitats and habitat-forming processes, restoration and enhancement of habitat along the mainstem and tributaries, and operation of Howard Hanson Dam in a manner that will reduce its adverse effects on flows, available habitat, and water quality downstream. The Strategy also calls for filling data gaps concerning the Upper Green River, such as those regarding baseline habitat quantity and quality and juvenile out-migration.

Near-Term Actions

Because the WRIA 9 Strategy identifies restoring fish passage to and from the Upper Green River subwatershed as a high priority, the WRIA has developed one near-term action to support that goal. Many of the WRIA-wide actions also will apply to the Upper Green River. See the box at the end of this section for a summary of WRIA-wide near-term actions.



UG Action 1: Endorse the re-establishment of fish passage to and from the Upper Green River subwatershed.

As part of the Tacoma Habitat Conservation Plan and the Additional Water Storage Project (described below), Tacoma and the U.S. Army Corps of Engineers will develop upstream and downstream passage at the two dams. The two agencies will coordinate these activities with the National Marine Fisheries Service, the U.S. Fish and Wildlife Service, the Washington State Department of Fish and Wildlife, and appropriate tribal fisheries managers. WRIA 9 endorses these activities and will provide support where feasible and appropriate.

- **Benefit to salmon:** Opening the Upper Green River subwatershed to salmon will dramatically expand the spawning and rearing habitat available in WRIA 9.
- **Link to Strategy:** Connects Upper Green to the rest of the watershed.
- **Implementation:** The WRIA will work to provide appropriate support to Tacoma and the U.S. Army Corps of Engineers.
- **Approximate cost:** Varies according to the action taken.

Summary of WRIA-Wide Near-Term Actions

The following near-term actions apply to each subwatershed in WRIA 9.

- WW Action 1: Develop an inventory of currently productive fish habitat in WRIA 9 based on the *Reconnaissance Assessment* and additional research, and identify the habitat-forming processes associated with that habitat.
- WW Action 2: Protect habitat and habitat-forming processes identified in WW Action 1 or where other efforts have identified important habitat.
- WW Action 3: Determine fish use and habitat priorities within jurisdictions.

- WW Action 4: Apply existing incentives (and where necessary, develop new incentives) for protection of salmon habitat in WRIA 9.
- WW Action 5: Identify existing educational and outreach materials for promoting salmon conservation messages and make them available for use by all on a website or on loan.
- WW Action 6: Encourage people to contribute personally to salmon conservation through high-visibility, enticing outreach efforts focused on the theme of lawn and garden care.
- WW Action 7: Improve enforcement of existing regulations that protect salmon and salmon habitat.
- WW Action 8: Evaluate adequacy of existing regulations to protect riparian buffers and improve them where necessary to maintain functions that protect fish habitat.
- WW Action 9: Promote the use of alternative shoreline protection techniques.
- WW Action 10: Evaluate and improve erosion and sediment control programs to reduce sediment entering salmon-bearing streams.
- WW Action 11: Adopt stormwater standards that protect salmon.
- WW Action 12: Develop programs and protocols for the maintenance of stormwater systems and facilities to reduce entry of sediment to salmon streams.
- WW Action 13: Review road maintenance practices and adopt written operating procedures to reduce potential impacts to salmon and other pollutants and salmon habitat.
- WW Action 14: Review parks and grounds maintenance procedures and adopt written best management practices that protect salmon and salmon habitat.
- WW Action 15: Develop a comprehensive, WRIA-wide process to identify, develop, and prioritize projects that benefit salmon and carry out the WRIA 9 Strategy.
- WW Action 16: Create combined naturalist and stewardship activities across WRIA 9.
- WW Action 17: Encourage the restoration of riparian buffers.
- WW Action 18: Implement Phase 1 of the Ecosystem Restoration Project.
- WW Action 19: Evaluate fish passage barriers at the local jurisdiction level.
- WW Study 1: Monitor habitat restoration projects to determine fish response and apply the information to future projects.
- WW Study 2: Identify which factors are limiting to salmon populations by subwatershed.
- WW Study 3: Develop a research framework for assessing juvenile salmon survival in WRIA 9.
- WW Study 4: Support the Green/Duwamish Water Quality Assessment.
- WW Study 5: Conduct an assessment of large woody debris recruitment in WRIA 9.
- WW Study 6: The WRIA 9 Planning Work Group, WRIA 9 Technical Committee, Central Puget Sound Water Suppliers Forum, and other appropriate agencies should work together to understand and evaluate the water budget for people and fish in the WRIA.
- WW Study 7: Develop mechanisms to increase collaboration and coordination in scientific work directed toward salmon recovery.

Current Efforts

Forestry

As noted above, nearly all of the Upper Green River subwatershed is devoted to forestry. Three major landowners (Plum Creek Timber Company, Tacoma Public Utilities, and the Washington State Department of Natural Resources) have developed Habitat Conservation Plans that

establish forest practices on their lands. These Habitat Conservation Plans provide them with incidental take permits under the Endangered Species Act and establish a variety of protection measures, including riparian management, monitoring and research, and road management. On lands not covered by a Habitat Conservation Plan, the current forest practices rules govern timber management. The Forest and Fish Agreement developed the original rules, which were modified in 2000 and again in 2001, and are codified in WAC 222.

Perhaps the most important aspect of these initiatives for salmon recovery is their emphasis on riparian management. As the WRIA 9 *Habitat Limiting Factors and Reconnaissance Assessment* report notes, riparian corridors are vital for providing shade and detritus, protecting water quality, and recruitment of large woody debris. Appendix B compares the riparian management provisions of the three HCPs and the Forest Practices Rules.

In addition, the Washington State Department of Natural Resources and Tacoma Public Utilities will conduct studies and monitoring as part of their Habitat Conservation Plans. Those studies that will generate data about listed species and their habitat are listed below in Table 2.

Table 2. Upper Green River studies: Washington State Department of Natural Resources and Tacoma Public Utilities Habitat Conservation Plans.

Study Name	Objective	Description	Factor of Decline Addressed	Jurisdiction
Upland Forest Management Monitoring	Document compliance with terms of the Tacoma Habitat Conservation Plan	Ensure management practices outlined in HCP are followed	Riparian condition, sediment transport, water quality	Tacoma Public Utilities
Riparian Buffer Width Monitoring	Document compliance with terms of the Tacoma Habitat Conservation Plan	Measure average no-harvest buffer widths	Riparian condition	Tacoma Public Utilities
Road Construction and Maintenance Monitoring	Document compliance with terms of the Tacoma Habitat Conservation Plan	Ensure management practices outlined in HCP are followed	Riparian condition, sediment transport	Tacoma Public Utilities
Snag and Green Tree Recruitment Effectiveness Monitoring	Document effectiveness of measures described in the Tacoma Habitat Conservation Plan	Ensure rate of snags and green tree recruitment meets needs of HCP species	Riparian condition	Tacoma Public Utilities
Uneven-aged Harvest Monitoring and Adaptive Management	Document effectiveness of measures described in the Tacoma Habitat Conservation Plan	Document whether windthrow has resulted in individual stands containing an average of less than 25 healthy dominant or codominant conifers per acre 5 years after harvesting	Riparian condition	Tacoma Public Utilities

Study Name	Objective	Description	Factor of Decline Addressed	Jurisdiction
Relationships between forest management and riparian ecosystems	Provide information to improve management practices	Develop basic information on the relationships between forest management activities and riparian ecosystems in managed forests	Riparian condition	Washington State Department of Natural Resources
Relationships between forest management activities and hydrology in managed forests	Provide information to improve management practices	Develop basic information on the relationships between forest management activities and hydrology in managed forests, particularly the relationships among forest management activities, basin soils, and stream-channel/stream-bed changes during rain-on-snow floods	Hydrology	Washington State Department of Natural Resources

The Tacoma Habitat Conservation Plan and the Additional Water Storage Project

Tacoma Public Utilities draws its water supply from the Green River at the Tacoma diversion dam in the Middle Green River subwatershed and will increase the amount of water it diverts in future years as part of the Second Supply Project. Tacoma Public Utilities recently developed a Habitat Conservation Plan in concert with the National Marine Fisheries Service and the U.S. Fish and Wildlife Service as noted above. With the completion of the Habitat Conservation Plan, Tacoma Public Utilities received incidental take permits in July 2001 to cover most of its activities¹⁵ in WRIA 9. The HCP establishes habitat restoration and fish passage projects to enhance conservation. The Tacoma Habitat Conservation Plan has seven primary components: fish passage at the Tacoma diversion dam, both up and downstream; reintroduction of large woody debris; reintroduction of gravel; habitat restoration projects; wildlife conservation measures; stream flow management; and monitoring.






Tacoma's Habitat Conservation Plan is closely intertwined with the U.S. Army Corps of Engineers' Additional Water Storage Project, which will store most of the additional water necessary for Tacoma's new water supplies. The project also will create a downstream fish passage facility at Howard Hanson Dam and construct numerous fish habitat restoration projects in the Middle and Upper Green River subwatersheds, such as reconnecting side channels and installing large woody debris. Tacoma, the City of Seattle, the City of Kent, Covington Water




¹⁵ The Habitat Conservation Plan does not cover the construction of the new 33.5-mile pipeline to carry the additional water to Tacoma, Seattle, Federal Way, Kent, and Covington.

District, Lakehaven Utility District, and the U.S. Army Corps of Engineers are sharing the cost of the Additional Water Storage Project.

Table 3 below describes the habitat projects that will be constructed in the Upper Green River subwatershed as part of the Tacoma Habitat Conservation Plan and the Additional Water Storage Project. Some similar projects have been combined for simplicity of presentation (e.g., culvert replacement projects).

Table 3. Upper Green River habitat projects: Tacoma Habitat Conservation Plan and the U.S. Army Corps of Engineers Additional Water Storage Project.

Project Name and Status	Project Description	Benefits to Salmon	Factors of Decline Addressed	Strategy Elements Addressed
Tacoma diversion dam upstream fish passage facility  Status:	Construct fish ladder and trap-and haul system to pass fish upstream over the dam. Also, reshape channel in front of dam to make fish ladder more attractive to fish.	Increased spawning area for adults of all species	Fish passage	Access to Upper Green River subwatershed
Tacoma diversion dam downstream fish passage facility  Status:	Modify the existing diversion dam to safely pass fish downstream and prevent fish from entering the diversion dam intake.	Increased output of juvenile salmon of all species	Fish passage	Connection of Upper Green River to rest of watershed
Tacoma diversion dam large woody debris/ rootwad placement  Status:	Place large woody debris and rootwads in two sections of the inundation pool upstream of the diversion dam.	Increased habitat complexity for all species	Hydro-modification	Rehabilitate habitat along the mainstem
Howard Hanson Dam downstream fish passage facility  Status:	Provide funding to the U.S. Army Corps of Engineers to design and construct a downstream fish passage facility at Howard Hanson Dam.	Increased output of juvenile salmon of all species	Hydro-modification	Connection of Upper Green River to rest of watershed
Standing timber retention  Status:	Leave 229 acres of timber standing within the new inundation zone of the Howard Hanson Dam reservoir	Increased habitat complexity of all species	Hydro-modification	Rehabilitate habitat along the mainstem

Project Name and Status	Project Description	Benefits to Salmon	Factors of Decline Addressed	Strategy Elements Addressed
Restore former mainstem channel alignment (RM 87)  Status:	Construct a new bioengineered bank to divert water back into historical channel	Improved access to complex habitat for juvenile chinook	Hydro-modification	Rehabilitate habitat along mainstem
Upper Green River tributary improvements  Status:	Improve riparian management areas, place bar apex jams, place inundation tolerant plants, place woody debris booms, etc.	Increased habitat complexity and quality for chinook and coho	Riparian condition, hydro-modification	Rehabilitate habitat along tributaries
Upper Green River tributaries culvert replacements  Status:	Replace existing culverts with bottomless culverts or bridges	Access to habitat for coho, steelhead, and possibly bull trout	Fish passage	Rehabilitate habitat along tributaries

The Tacoma Habitat Conservation Plan and the Additional Water Storage Project also involve several studies, outlined in Table 4 below. All of these studies address the element of the WRIA 9 Strategy that calls for filling data gaps in the Upper Green River subwatershed.

Table 4. Upper Green River studies: Tacoma Habitat Conservation Plan and the Additional Water Storage Project.

Study Name	Objective	Description	Factor of Decline Addressed
Snowpack and precipitation monitoring	Improve the ability of U.S. Army Corps of Engineers to predict stream flows	Provide funding to the U.S. Army Corps of Engineers to install three snowpack and precipitation monitoring stations in the Upper Green River subwatershed	Hydrology
Minimum instream flow monitoring	Document compliance with terms of the Tacoma Habitat Conservation Plan	Monitor instream flows and Tacoma Public Utilities operations that affect instream flows	Hydrology
Non-dedicated water storage and flow management monitoring	Document compliance with terms of the Tacoma Habitat Conservation Plan	Monitor amounts of water available for municipal water supply and for flow augmentation	Hydrology
Tacoma diversion dam rehabilitation monitoring	Document compliance with terms of the Tacoma Habitat Conservation Plan	Ensure projects carried out as prescribed; check on stability over time	Hydromodification

Study Name	Objective	Description	Factor of Decline Addressed
Tacoma diversion dam upstream fish passage monitoring	Document compliance with terms of the Tacoma Habitat Conservation Plan	Ensure fish are using the ladder and that water quality is unaffected	Fish passage
Tacoma diversion dam downstream fish passage monitoring	Document compliance with terms of the Tacoma Habitat Conservation Plan	Ensure debris is passed downstream and spillways are designed to minimize risk of injury to downstream migrants	Fish passage
Monitor the transport of juvenile fish above Howard Hanson Dam	Document compliance with terms of the Tacoma Habitat Conservation Plan	Document funding or implementation of transport of juveniles	Fish passage
Mainstem woody debris management monitoring	Document compliance with terms of the Tacoma Habitat Conservation Plan	Maintain database of amount of large woody debris removed from reservoir and how it is used	Hydromodification
Upper watershed stream, wetland, and shoreline rehabilitation monitoring	Document compliance with terms of the Tacoma Habitat Conservation Plan	Monitor large woody debris emplacements, instream vegetation, and fish passage at various restoration sites	Hydromodification, riparian condition, fish passage
Monitor movement of juvenile fish into reservoir	Identification of species, timing, size and age distribution of fish moving downstream into Howard Hanson Dam reservoir	Seasonal installation of fyke net in upper mainstem	Fish passage
Monitor reservoir passage of juvenile fish	Determine fish distribution throughout reservoir during peak migration times	Conduct mobile hydroacoustic fish surveys of Howard Hanson Dam reservoir	Fish passage
Monitor fish passage facility survival and fish collection efficiency	Provide data on reservoir and project passage facility efficiency and survival	Paired PIT tag releases and detection	Fish passage
Monitor fish passage facility survival and fish collection efficiency	Provide data on reservoir and project passage facility efficiency and survival	Seasonal operation of screw trap at Howard Hanson Dam outlet but upstream of fish bypass outfall	Fish passage
Monitor condition of fish passing through fish passage facility	Provide data on reservoir and project passage facility efficiency and survival	Sample fish at station upstream of outfall	Fish passage
Marked fry	Quantify efficiency of modular-inclined screen and fish passage facility	Mark and recapture fish to determine efficiency of sampling station	Fish passage




Study Name	Objective	Description	Factor of Decline Addressed
Hydroacoustic surveys	Determine whether juvenile fish can find and use bypass system	Fixed hydroacoustics deployed in Howard Hanson Dam forebay, fish passage facility horn, and wetwell. Mobile hydroacoustic monitoring and gillnetting in reservoir. Placement of transducers in passage facility.	Fish passage
Monitor water quality and zooplankton in the reservoir	Identify gross changes in reservoir productivity and salmon eating habits as a result of implementing the Additional Water Storage Project	Spring and summer surveys in the upper and lower portions of the reservoir	Water quality
Monitor predator abundance in the reservoir	Compare the effects of the Additional Water Storage Project on predator rates and consumption	Snorkel surveys to identify concentrations of predatory fish at migratory transition points, hook and line or nets to collect stomach samples	Study to fill data gaps
Monitor effects of flow management strategies on side channels	Provide data on quality and quantity of side channel habitat at various flow conditions; quantify biological response	Quantify inlet/outlet elevations, map large woody debris, conduct snorkel and electrofishing surveys	Hydromodification
Monitor steelhead spawning and incubation	Evaluate the effects of released flows on steelhead spawning and egg incubation	Contribute funding to the Washington State Department of Fish and Wildlife and the Muckleshoot Indian Tribe spawner surveys	Hydromodification

The Green/Duwamish Ecosystem Restoration Project

In 1995, the U.S. Army Corps of Engineers and a group of jurisdictions in the Green/Duwamish Watershed sponsored and conducted a reconnaissance study of the watershed. This study recommended a feasibility study of over 50 sites basin-wide that could be restored to benefit habitat. This feasibility study, conducted from 1997 to 2000, provided conceptual designs for future construction of 45 of these sites over 10 years. This restoration program, authorized by the Water Resource Development Act of 2000, is moving into the project engineering and design phase in early 2002, in which detailed designs and engineering studies will be completed for 20 projects that are ready to build. Construction of these projects will begin in 2003.

Several of these Phase 1 projects will be constructed in the Upper Green River subwatershed. Table 5 below summarizes information about those projects that will benefit chinook salmon. Other Green/Duwamish Ecosystem Restoration projects are listed in the subwatershed in which they are located. Those that benefit species other than the chinook and bull trout are listed in Appendix C.

Table 5. Upper Green River projects: Green/Duwamish Ecosystem Restoration Project.

Project Name and Status	Project Description	Benefits to Salmon	Factors of Decline Addressed	Strategy Elements Addressed
Sunday Creek revegetation  Status:	Plant low-growing riparian species under the powerlines and place large wood in the stream	Increases habitat complexity and quality for coho, steelhead, and possibly chinook	Riparian condition, hydromodification, water quality	Rehabilitate habitat along the tributaries
Gale Creek  Status:	Replace perched culvert with a bridge	Opens up habitat for chinook, steelhead, coho, and possibly bull trout	Fish passage	Restore access to tributaries
Sweeny Creek culvert replacement  Status:	Replace existing culvert and improve riparian corridor	Opens up habitat for bull trout (possibly), coho, steelhead, and cutthroat trout	Fish passage, riparian condition	Restore access to tributaries, rehabilitate tributary habitat

The Green/Duwamish Ecosystem Restoration Project also will conduct studies to guide the restoration projects. One of these studies is watershed-wide (except the Nearshore subwatershed) and is described below in Table 6.

Table 6. Upper Green River studies: Green/Duwamish Ecosystem Restoration Project.

Study Name	Objective	Description	Factor of Decline Addressed
Water quality	Quantify changes in water quality parameters resulting from restoration projects	Sample transects in the proximity of restoration projects using a hydrolab and two-person crew	Water quality



Middle Green River Subwatershed

Background

The Middle Green River subwatershed extends from Howard Hanson Dam (RM 64.5) to the confluence of Soos Creek with the Green River at RM 32. Just downstream of Howard Hanson Dam, Tacoma Public Utilities maintains its diversion dam, at which it diverts its drinking water. Below the diversion dam, the Green River flows between steeply sloped valley walls in mostly forested, mountainous terrain before emerging from the mouth of the Green River Gorge at the upstream end of Flaming Geyser State Park (RM 45.6). The river then flows through a broad valley down to its confluence with Soos Creek. However, levees and revetments constrain channel migration in significant portions of this reach without necessarily containing floods. Figure 6 is a map of the Middle Green River subwatershed.

Newaukum and Soos creeks are the major tributaries to the Middle Green River. The Green River fish hatchery, built in 1901-02 and still in operation, is on Soos Creek.

The major land uses in the Middle Green River are residential-zoned land (50 percent), forestry (27 percent), and agriculture (12 percent). Much of the subwatershed is in unincorporated King County, but the cities of Covington, Maple Valley, Black Diamond, and Enumclaw contribute a more urban character to a portion of the Middle Green River subwatershed. The urban growth area line bisects this subwatershed (Figure 1).

Forestry landowners include Plum Creek Timber, Weyerhaeuser, and other private landowners. Several state and local parks also abut the river, preserving mostly forested lands. One of the largest Agricultural Production Districts in King County is in the Middle Green River subwatershed near Enumclaw, and many of the parcels are in the Farmland Preservation Program. Both receiving sites (sites that take additional development density) and sending sites (sites that reduce development density) associated with the Transfer of Development Rights program could be located in this subwatershed.

Fish Use

Almost all chinook salmon spawning areas in the WRIA are in the Middle Green River subwatershed, and thus this subwatershed is critical to salmon conservation. Juvenile salmon also use Middle Green River habitats extensively for rearing and hiding from predators. Both adults and juveniles take refuge from floods in side channels and other off-channel habitats. Coho salmon, chum salmon, and steelhead also spawn in the Middle Green River, along with some sockeye and pink salmon. All species, except for bull trout, are known to use this area for migration and feeding. A small number of bull trout have been captured in the Middle Green River, but scientists are not certain how they use the Middle Green River. Recently, kokanee have been reported in Deep Lake in the Middle Green River. They are believed to be Lake Whatcom stock planted from the Arlington hatchery in 1969 and 1970.

Factors of Decline and Strategy

The two dams, revetments, and residential and agricultural land uses have had adverse effects on salmon habitat in the Middle Green River mainstem, including water withdrawals, changes in the natural flow regime, sediment starvation and scouring, and the loss of side channels, other off-channel habitat, riparian habitat functions, and large woody debris. In the tributaries, residential, urban, and agricultural development have resulted in loss of wetlands and riparian habitat function, disruptions to hydrology, degraded channels and water quality, re-channeled streams with limited lateral migration, loss of large woody debris, and barriers to fish passage.

The WRIA 9 Strategy calls for a number of actions to address these problems. For the Middle Green River, preservation of currently functioning habitat is a high priority because this subwatershed contains the majority of spawning grounds for wild chinook. Protection of the most productive spawning and rearing areas, both in the mainstem and tributaries, is also recommended. In addition, a suite of restoration and enhancement actions is aimed at overcoming the effects of the natural processes interrupted by the two dams. These include large woody debris input, gravel transportation, and more natural flow regimes. The Strategy also calls for reconnecting side channels that were cut off by changes in the flow regime, levees, revetments, or other alterations. In the tributaries, the Strategy recommends enhancing habitat and removing fish passage barriers.

Near-Term Actions

WRIA 9 recognizes that action is necessary to protect salmon and their habitat in this subwatershed. Those actions specific to the Middle Green River are described below and grouped according to the four categories in the WRIA 9 Strategy. Actions described earlier in the WRIA-wide chapter of this document also apply and are meant to be implemented in this subwatershed. Please see the box at the end of this section for a summary of WRIA-wide near-term actions.

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Figure 6. Middle Green River Subwatershed.

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MG Action 1: Maximize retention of forest cover and minimize impervious surfaces in rural and forest production areas of the Middle Green River subwatershed.

WRIA 9 should support efforts to maximize retention of existing forest cover, encourage restoration of forest cover where determined to be beneficial, and minimize impervious surfaces in rural and forest production areas of the Middle Green River subwatershed. A variety of tools might be used to meet this goal, including acquisition of land or easements, land lease agreements, transfer of development rights, tax incentive programs, and development regulations. King County should evaluate these options for application in rural and forest production areas of the Middle Green River subwatershed. Limiting changes in land cover reduces flow volume increases, peak flows that cause flooding, and flow duration increases that cause stream erosion and adverse impacts to salmon. Forest retention also helps maintain groundwater recharge that is important for maintenance of baseflows and water temperatures.

The WRIA 9 Strategic Assessment should use the best available science to evaluate what forest cover and impervious surface limits are necessary to protect and support salmon habitat in the Middle Green River subwatershed, in the context of the entire WRIA.

- **Benefit to salmon:** Retaining forest cover reduces the loss of forested areas, minimizing alterations to natural hydrological conditions and water temperatures.
- **Link to Strategy:** Protect critical habitats and habitat-forming processes.
- **Implementation:** King County will lead this effort. The WRIA will provide political and scientific support to the County.
- **Approximate cost:** Staff time and about \$20,000 of GIS support.



MG Action 2: Identify and pursue opportunities on agricultural lands to enhance or restore high quality salmon habitats while maintaining viable agriculture.

The intent of this action is to improve overall salmon habitat while preserving or enhancing agricultural opportunities. Agricultural activities along the mainstem Green River and Newaukum Creek occur adjacent to some of the most important remaining spawning and rearing habitat in the watershed. Currently, deed restrictions and other public policies and regulations create limitations for salmon habitat restoration activities on agricultural lands, both on lands that are part of the Farmland Preservation Program and on other lands. Restoration projects on Farmland Preservation Program properties must be designed and installed in a manner that will ensure that the county's obligation to preserve the property for agricultural purposes remains intact. The Conservation Reserve Enhancement Program, a joint partnership between the State of Washington and the U.S. Department of Agriculture, offers another opportunity to enhance salmon habitat through landowner incentives.

- **Benefit to salmon:** Improving salmon habitat in the Middle Green River mainstem and Newaukum Creek basin will enhance the spawning and rearing functions of these areas.
- **Link to Strategy:** Rehabilitate aquatic and riparian habitat.
- **Implementation:** King County should work with the agricultural community to pursue opportunities while maintaining viable agricultural use of the land.
- **Approximate cost:** Unknown, mostly staff costs.

King County should identify sites where habitat restoration projects, such as improving the quality of existing buffers, could be pursued using any of these tools, and work with the agricultural community to pursue habitat restoration while maintaining viable agricultural use of the land.



MG Action 3: Supplement mainstem gravel and large woody debris.

The U.S. Army Corps of Engineers, Tacoma Public Utilities, and the jurisdictions of WRIA 9 plan to place gravel and large woody debris in the Middle Green River as part of the Additional Water Storage Project, Tacoma's Habitat Conservation Plan, and the Green/Duwamish Ecosystem Restoration Project. WRIA 9 jurisdictions will take an active role in these projects through the Green/Duwamish Ecosystem Restoration Project, and should work with and provide support to Tacoma Public Utilities and the U.S. Army Corps of Engineers.

- **Benefit to salmon:** The gravel will protect and enhance spawning areas. Installation of large woody debris will help increase habitat complexity in the mainstem.
- **Link to Strategy:** Rehabilitate critical interrupted processes, such as gravel transport and large woody debris input.
- **Implementation:** WRIA 9 jurisdictions will conduct this action with the U.S. Army Corps of Engineers.
- **Approximate cost:** \$1,000,000 for large woody debris over 10 years; \$800,000 for gravel over 3 years.



MG Action 4: Prevent degradation of important sources of cool, clean water in the Middle Green River subwatershed.

Surface and groundwater inputs to the Middle Green River that provide cool, clean water that supports salmon spawning and rearing should be protected. Important sources include springs originating in the Deep and Coal Creek subbasins and tributaries to the Green River such as Icy Creek. Much of this area is within the King County Forest Production District or designated as rural forest focus areas in the King County Comprehensive Plan.

The impacts of rural development on these areas should be minimized through a combination of one or more of the following voluntary techniques:

- Low impact development techniques including maximizing forest retention, minimizing impervious surface, clustering, designating open space tracts, and various water conservation and retention measures.
- Acquisition and transfer of development rights (TDR) into a TDR bank or a privately funded TDR transfer to an urban receiving site
- Land acquisition in fee (see also WW Action 2, MG Action 1).

- **Benefit to salmon:** Cool, clean sources of water are an important habitat condition in areas that support spawning and rearing of salmon, especially chinook and bull trout.
- **Link to Strategy:** Protect functioning habitat, water quality.
- **Implementation:** King County, other local jurisdictions as appropriate.
- **Approximate cost:** Varies by action.

MG Study 1: Assess flow management alternatives in the Middle Green River.

The purpose of this study is to focus attention on the need to manage river flows to maximize salmon habitat in the Middle Green River and to begin the collection of data about important physical parameters needed to implement such a flow regime. River flows are responsible for many of the important habitat creation and maintenance processes in a river system. This project will involve determining the discharge quantities and the duration and frequencies of flows necessary to create and maintain specific habitat types in the Middle Green River. In addition, the project will include a side channel study to document the flows needed to provide water to important side channels.

- **Benefit to salmon:** A natural flow regime may protect existing habitat and create new habitat.
- **Link to Strategy:** Study to fill data gaps.
- **Implementation:** The WRIA 9 Technical Committee will oversee this work.
- **Approximate cost:** \$50,000

MG Study 2: Identify gravel source areas in the Middle Green River.

This project will identify the main sources of gravel to the Green River and its major tributaries in the Middle Green River. This project is necessary to assess the current condition of properly functioning habitat and to identify potential quantities and areas for gravel augmentation. A simple but important method of conducting this study would be to inventory landslides in the Middle Green River. A more thorough study would create a sediment budget for the entire Green River downstream of Howard Hanson Dam. The U.S. Army Corps of Engineers' draft Hydrologic Engineering Management Plan recommends this more thorough type of project, and it is likely that the U.S. Army Corps of Engineers will manage this study.

- **Benefit to salmon:** Allows a variety of agencies to augment spawning gravel in the sub-watershed.
- **Link to Strategy:** Study to fill data gaps.
- **Implementation:** U.S. Army Corps of Engineers may conduct this study.
- **Approximate cost:** Unknown.

MG Study 3: Identify and characterize important surface and groundwater inputs to the Middle Green River.

This study would have two steps: mapping of watershed conditions and areas that support cool water inputs, and evaluating how land use and land cover changes in the Middle Green River affect water temperatures, both locally and regionally. This study would be coordinated closely with the Green/Duamish Water Quality Assessment (see WW Study 4). Relationships between geology, soils, and groundwater flow in the vicinity of the historic confluence of the Green and White rivers and the Deep and Coal Creek subbasins will be the primary focus of the study.

- **Benefit to salmon:** Sources of cool, clean water are an important habitat condition in areas that support spawning and rearing of salmon. Identifying them will help the WRIA protect these sources.
- **Link to Strategy:** Study to fill data gaps.
- **Implementation:** The WRIA 9 Technical Committee will oversee this work.
- **Approximate cost:** \$70,000 - \$100,000

MG Study 4: Ensure funding for the Green River fish trap for 2003–2005.

The fish trap at RM 34 is a basic research tool for understanding wild salmon productivity in WRIA 9. The trap is situated just above the confluence with Soos Creek, allowing a measure of wild juvenile salmon out-migration from the Middle Green River and Newaukum Creek. In addition, now that hatchery chinook salmon have clipped fins, the WRIA will soon be better able to correlate juvenile productivity and adult returns of wild stock.

The trap has been funded by the Washington State Department of Fish and Wildlife in 2001 and 2002 and will be funded again after 2005. However, no firm funding is currently identified for 2003–2005. WRIA 9 needs to make sure that the trap continues to operate so that the monitoring of salmon success in this reach of the river can be improved.

- **Benefit to salmon:** Understanding wild productivity in the lower river ultimately will allow identification of reaches that may be limiting.
- **Link to Strategy:** Study to fill data gaps through salmonid survival studies.
- **Implementation:** The WRIA will lobby WDFW to find funding for the fish trap.
- **Approximate cost:** \$100,000/year

Summary of WRIA-Wide Actions

The following WRIA-wide actions also will apply to the Middle Green River subwatershed.

- WW Action 1: Develop an inventory of currently productive fish habitat in WRIA 9 based on the *Reconnaissance Assessment* and additional research, and identify the habitat-forming processes associated with that habitat.
- WW Action 2: Protect habitat and habitat-forming processes identified in WW Action 1 or where other efforts have identified important habitat.
- WW Action 3: Determine fish use and habitat priorities within jurisdictions.
- WW Action 4: Apply existing incentives (and where necessary, develop new incentives) for protection of salmon habitat in WRIA 9.
- WW Action 5: Identify existing educational and outreach materials for promoting salmon conservation messages and make them available for use by all on a website or on loan.
- WW Action 6: Encourage people to contribute personally to salmon conservation through high-visibility, enticing outreach efforts focused on the theme of lawn and garden care.
- WW Action 7: Improve enforcement of existing regulations that protect salmon and salmon habitat.
- WW Action 8: Evaluate adequacy of existing regulations to protect riparian buffers and improve them where necessary to maintain functions that protect fish habitat.
- WW Action 9: Promote the use of alternative shoreline protection techniques.
- WW Action 10: Evaluate and improve erosion and sediment control programs to reduce sediment entering salmon-bearing streams.
- WW Action 11: Adopt stormwater standards that protect salmon.
- WW Action 12: Develop programs and protocols for the maintenance of stormwater systems and facilities to reduce entry of sediment to salmon streams.

- WW Action 13: Review road maintenance practices and adopt written operating procedures to reduce potential impacts to salmon and other pollutants and salmon habitat.
- WW Action 14: Review parks and grounds maintenance procedures and adopt written best management practices that protect salmon and salmon habitat.
- WW Action 15: Develop a comprehensive, WRIA-wide process to identify, develop, and prioritize projects that benefit salmon and carry out the WRIA 9 Strategy.
- WW Action 16: Create combined naturalist and stewardship activities across WRIA 9.
- WW Action 17: Encourage the restoration of riparian buffers.
- WW Action 18: Implement Phase 1 of the Ecosystem Restoration Project.
- WW Action 19: Evaluate fish passage barriers at the local jurisdiction level.
- WW Study 1: Monitor habitat restoration projects to determine fish response and apply the information to future projects.
- WW Study 2: Identify which factors are limiting to salmon populations by subwatershed.
- WW Study 3: Develop a research framework for assessing juvenile salmon survival in WRIA 9.
- WW Study 4: Support the Green/Duwamish Water Quality Assessment.
- WW Study 5: Conduct an assessment of large woody debris recruitment in WRIA 9.
- WW Study 6: The WRIA 9 Planning Work Group, WRIA 9 Technical Committee, Central Puget Sound Water Suppliers Forum, and other appropriate agencies should work together to understand and evaluate the water budget for people and fish in the WRIA.
- WW Study 7: Develop mechanisms to increase collaboration and coordination in scientific work directed toward salmon recovery.

Current Efforts

Jurisdiction and Stakeholder Efforts

Jurisdictions in the Middle Green River have implemented programs and policies to protect the resources found there. In the early to mid-1990s, most jurisdictions in the WRIA adopted stream buffer standards pursuant to the Growth Management Act requirements. For example, Covington requires a 100-foot buffer on salmon-bearing streams. Enumclaw is working with environmental groups to preserve 54 acres along Newaukum Creek, a tributary with chinook salmon spawning grounds. Black Diamond has consulting engineers available to assist city staff with reviewing development proposals to identify resource protection issues. King County is developing a Fish and Wildlife Habitat Conservation Areas Ordinance, scheduled for transmittal to the County Council in 2002, to improve protection for important habitat areas in the county, including those in the Middle Green River. King County also partners with the King Conservation District to help owners of rural, agricultural, and forested lands create management plans for their properties. Appendix A provides more detail about the activities of jurisdictions to protect salmon resources in WRIA 9.

Other organizations also have initiated programs to conserve salmon and their habitat. For example, the Covington Water District sponsors extensive public education programs about water conservation in homes and businesses, and conducts its own affairs in ways that conserve water.

Agriculture and Forestry

As noted above, agriculture and forestry are important land uses in the Middle Green River subwatershed. King County’s Farmland Preservation Program preserves agricultural land uses in perpetuity on dozens of parcels in the Middle Green River. At the state level, the Agriculture, Fish, and Wildlife negotiations are endeavoring to set buffers and other standards for all western Washington farms. In general, agricultural lands are more pervious than residential development and absorb runoff and protect flows. Buffers along agricultural parcels provide the shade, nutrients, and large woody debris important to salmon.

Several initiatives govern forestry practices in the Middle Green River. The Plum Creek Timber Habitat Conservation Plan, the Washington State Department of Natural Resources Habitat Conservation Plan, the Tacoma Public Utilities Habitat Conservation Plan, and the Forest Practices Rules (WAC 222) all set standards for riparian buffers and best management practices to protect salmon and their habitat. Table B-1 in Appendix B compares these standards.


Projects



The projects highlighted in this section are those that benefit listed species (or listed species and other species), and should begin sometime during the next five years. Appendix A describes projects undertaken by specific jurisdictions. Projects that benefit species other than chinook salmon and bull trout are described in Appendix C.

Jurisdiction Projects

On their own initiative, jurisdictions in the Middle Green River subwatershed are carrying out projects to protect salmon and their habitat. Table 7 below describes three projects that benefit listed species and will occur in the near-term.

Table 7. Middle Green River projects: WRIA jurisdictions.

Project Name and Status	Project Description	Benefits to Salmon	Factors of Decline Addressed	Strategy Elements Addressed	Jurisdiction	Partners
Conservation Futures Allocation Status: 	Partial funding for 106-acre acquisition adjacent to Middle Green River	Protects currently functioning habitat for all species	None; prevents further harm	Protect critical habitats and habitat-forming processes	King County	Mid-Sound Fisheries Enhancement Group





Project Name and Status	Project Description	Benefits to Salmon	Factors of Decline Addressed	Strategy Elements Addressed	Jurisdiction	Partners
Restoration of parks and lands adjacent to Green River and Soos Creek including Hatchery, Porter Levee, O’Grady, and Whitney Bridge parks  Status:	Controlling invasive vegetation and reestablishing native vegetation to improve riparian habitat	Improves existing streamside habitat	Degraded habitat	Enhance riparian habitat	King County	Soos Creek Area Response
Conservation Futures Allocation  Status:	54 acre acquisition adjacent to Newaukum Creek	Protects currently functioning habitat for all species	None; prevents further harm	Protect critical habitats and habitat-forming processes	Enumclaw	Possibly Mid-Sound Fisheries Enhancement Group and Trout Unlimited

Salmon Recovery Funding Board and King Conservation District Projects

WRIA 9 recommends projects for funding to two organizations: the Salmon Recovery Funding Board and the King Conservation District. The Salmon Recovery Funding Board is a state organization that disburses grants comprising a combination of state and federal funding for salmon habitat projects. The WRIA 9 Steering Committee selects projects to send to the Salmon Recovery Funding Board for its consideration. Property owners in King County support the King Conservation District with a \$5-per-parcel annual fee. The King Conservation District devotes three-fifths of this fee from parcels within WRIA 9 to salmon, water quality, and flooding projects. The WRIA 9 Forum approves projects to send to the King Conservation District Board for its consideration for this funding.

Several projects in the Middle Green River subwatershed are planned using these funding sources. Table 8 below describes each briefly.





Table 8. Middle Green River projects: Salmon Recovery Funding Board and the King Conservation District.

Project Name and Status	Project Description	Benefits to Salmon	Factors of Decline Addressed	Strategy Elements Addressed	Funding Source
Metzler acquisition Status: 	Acquire parcels adjacent to Metzler Park (Phase 1); install large woody debris (Phase 2)	For all species: protects existing high quality habitat (Phase 1); restores habitat complexity (Phase 2)	Hydro-modification (Phase 2)	Rehabilitate critical interrupted processes including large woody debris input	Salmon Recovery Funding Board (Phase 1); Ecosystem Restoration Program (Phase 2)
Middle Green River/ Kanaskat II acquisition Status: 	Acquire 154 acres to protect chinook spawning areas	For all species, preserves key habitat areas and processes	Protects functioning habitat	Protect critical habitats	Salmon Recovery Funding Board (with additional funding from King County Conservation Futures)
Middle Green River acquisitions Status: 	Acquire up to 110 acres near chinook spawning habitat	For all species, preserves key habitat areas and processes	Protects functioning habitat	Protect critical habitats	Salmon Recovery Funding Board (with additional funding from King Conservation District)
Big Spring Creek acquisition Status: 	Acquire key parcels in the headwaters of Big Spring Creek	For all species, protects water quality	Protects functioning habitat	Protect critical habitats	Salmon Recovery Funding Board

Non-Profit and Other Stakeholder Efforts

Several non-profit organizations are working actively to conserve salmon and their habitat in the Middle Green River subwatershed. Table 9 below provides information about planned and on-going projects.




Table 9. Middle Green River projects: non-profit organizations and other stakeholders.

Project Name and Status	Project Description	Benefits to Salmon	Factors of Decline Addressed	Strategy Elements Addressed	Lead Agency and Partners
Newaukum Creek wetland planting Status: 	90 volunteers helped plant 945 plants in this wetland mitigation upstream of Mahler Park; plantings continue	Wetlands protect water quality and provide nutrients for all species	Riparian condition, water quality	Rehabilitate critical habitat-forming processes	Mid-Sound Fisheries Enhancement Group (lead), Enumclaw High School, Boy Scouts of America, and local volunteers
Salmon carcass distribution Status: 	Annually distribute chinook and coho carcasses	Adds nutrients for all species	?	Rehabilitate critical habitat-forming processes	Mid-Sound Fisheries Enhancement Group (lead) and local volunteers
North Fork Newaukum planting Status: 	Plant riparian buffers at newly completed in-stream restoration project	Provides shade, nutrients, and large woody debris for all species	Riparian condition	Rehabilitate aquatic habitat within tributaries	Mid-Sound Fisheries Enhancement Group (lead), local volunteers, and the Boy Scouts of America
North Fork Newaukum Creek in-stream restoration Status: 	Restored 250 feet of the creek by re-grading bank slopes and installing large woody debris; planting will occur in 2002	Provides sediment sources, habitat complexity, shade, nutrients, and large woody debris for all species	Hydromodification, riparian condition, sediment transport	Rehabilitate critical habitat-forming processes	Mid-Sound Fisheries Enhancement Group (lead) and the Washington Conservation Corps

Status: 

As discussed above in the Upper Green River subwatershed section, Tacoma Public Utilities and the U.S. Army Corps of Engineers plan to construct a number of habitat projects in the Middle Green River. These projects are described below in Table 10.

Status: 

Project Name and Status	Project Description	Benefits to Salmon	Factors of Decline Addressed	Strategy Elements Addressed
Bar apex jams below the Tacoma diversion dam (RM 60)  Status:	Construct bar apex jams along Palmer Reach, especially in vicinity of Kanaskat Side Channel	Increases habitat complexity for all species	Hydromodification	Rehabilitate critical habitat-forming processes
Side channel reconnection - Signani Slough (RM 60)  Status:	Connect slough to mainstem, create pool-riffle sequence, create spawning reach downstream of pool-riffle reach; maintain and enhance existing pond with large woody debris; excavate backwater channels, place large woody debris, construct holding pool and reestablish side channel outlet.	Provide additional rearing habitat, habitat complexity, and habitat connectivity for all species	Hydromodification	Connect mainstem with side channels and floodplain habitat
Downstream woody debris management program  Status:	Work with the Muckleshoot Indians and federal and local agencies to develop a program to distribute large and small woody debris that collects behind Howard Hanson Dam in the Middle and Lower Green River	Provides additional rearing habitat and habitat complexity for all species	Hydromodification	Rehabilitate critical habitat-forming processes

The Green/Duwamish Ecosystem Restoration Project







In 1995, the U.S. Army Corps of Engineers and a group of jurisdictions in the Green/Duwamish Watershed sponsored and conducted a reconnaissance study of the watershed. This study recommended a feasibility study of over 50 sites basin-wide that could be restored to benefit habitat. This feasibility study, conducted from 1997 to 2000, provided conceptual designs for future construction of 45 of these sites over 10 years. This restoration program, authorized by the Water Resource Development Act of 2000, is moving into the project engineering and design phase in early 2002, in which detailed designs and engineering studies will be completed for 20 projects that are ready to build. Construction of these projects will begin in 2003.

Several of these Phase 1 projects will be constructed in the Middle Green River subwatershed. Table 11 below summarizes information about those projects that will benefit chinook salmon and bull trout.

Note that the volunteer revegetation project will occur also in the Lower Green River and Elliott Bay/Duwamish subwatersheds but is described in this document only once. In addition, large

woody debris may be placed in the Lower Green River and Elliott Bay/Duwamish subwatersheds. Finally, note that the water quality studies described in Table 6, Upper Green River studies, also will be carried out in the Middle Green River subwatershed.

Table 11. Middle Green River projects: Green/Duwamish Ecosystem Restoration Project.

Project Name and Status	Project Description	Benefit to Salmon	Factors of Decline Addressed	Strategy Element Addressed
Kanaskat side channel north (Brunner Slough) (RM 58)  Status:	Construct permanent access between the river and the downstream end of this former river meander, and tie the channel into a supplemental water source	Provides refuge habitat for all species	Hydromodification	Connect the mainstem with side channels
Lones Levee  Status:	Remove training levee, replace with small setback levee well landward and with a significant buried toe, relocate the lower portion of Burns Creek into its original channel	Increases habitat quality for all species	Hydromodification	Enhance aquatic habitat within the mainstem
Middle Green River gravel  Status:	Place up to 5000 cubic yards of gravel per year in the Middle Green River	Protects and expands spawning habitat for chinook and other species	Hydromodification, sediment transport	Rehabilitate critical interrupted processes
Newaukum Creek  Status:	Phase 1 proposal: restore about one-third of the creek upstream from its confluence with the Green River by placing large woody debris in the stream and planting riparian corridors	Increases habitat complexity for all species	Hydromodification, riparian condition	Enhance aquatic habitat within the tributaries
Middle Green River large woody debris demonstration project  Status:	Place up to 40 logjams in the Middle Green River over 10 years	Increases habitat complexity for all species	Hydromodification	Enhance aquatic habitat within the mainstem
Volunteer revegetation  Status:	Provide plants, wood, and other materials for riparian restoration projects conducted by volunteers, schools, and other stakeholder groups	Provides shade, nutrients, and large woody debris for all species	Riparian condition, water quality	Enhance aquatic habitat within the mainstem

Studies

Jurisdiction Studies and Data Collection

Jurisdictions in WRIA 9 are conducting studies to provide data that will aid in management decisions. These studies are described in Table 12 below. All of these studies fulfill the Strategy in that they fill data gaps about the Middle Green River.

Table 12. Middle Green River studies: WRIA jurisdictions.

Study Name	Objective	Description	Factor of Decline Addressed	Jurisdiction
Green Water Quality Assessment	Assess current and future water quality conditions in the Middle Green River	Analyze peak concentrations and loadings, conduct water quality modeling	Water quality	King County
Benthic index of biological integrity	Determine overall health of streams	Monitor aquatic insect populations using benthic index of biological integrity	Water quality, riparian condition	King County
Stream gauging	Measure stream flow	Install and monitor stream gauges in tributaries	Hydrology	King County
Green temperature study	Examine spatial variability in stream temperatures; identify cool/warm areas	Continuous monitoring of stream temperatures, and modeling	Water quality	King County

Non-Profit and Other Stakeholder Studies

Other organizations are conducting research in the Middle Green River as well. Table 13 below briefly describes one such effort.

Table 13. Middle Green River study: Non-profit organizations and other stakeholders.

Study Name	Objective	Description	Factor of Decline Addressed	Lead Agency and Partners
Smolt trap on north fork Newaukum Creek	Provide data to managers to aid decisions	Annually monitor coho smolts and resident cutthroat heading downstream in spring	Study to fill data gaps	Mid-Sound Fisheries Enhancement Group (lead), Trout Unlimited, and local volunteers

Tacoma Habitat Conservation Plan and Additional Water Storage Project Studies

Under these two programs, Tacoma Public Utilities and the U.S. Army Corps of Engineers plan to conduct numerous studies to guide their efforts and to ensure compliance with Tacoma Public Utilities' agreement with the National Marine Fisheries Service. These studies are described in Table 14 below; all of them are consistent with the WRIA 9 Strategy because they fill data gaps about the Middle Green River.

Table 14. Middle Green River studies: Tacoma Habitat Conservation Plan and the U.S. Army Corps of Engineers Additional Water Storage Project.

Study Name	Objective	Description	Factor of Decline Addressed
Minimum instream flow monitoring	Document compliance with terms of Tacoma Habitat Conservation Plan	Monitor instream flows and Tacoma Water operations that affect instream flows	Hydrology
Non-dedicated water storage and flow management monitoring	Document compliance with terms of Tacoma Habitat Conservation Plan	Monitor amounts of water available for water supply and flow augmentation	Hydrology
Signani Slough monitoring	Document compliance with terms of Tacoma Habitat Conservation Plan	Monitor stability of anchored large woody debris	Hydromodification
Mainstem woody debris management monitoring	Document compliance with terms of Tacoma Habitat Conservation Plan	Maintain database of large woody debris removed from reservoir and how it is used	Hydromodification
Mainstem gravel nourishment monitoring	Document compliance with terms of Tacoma Habitat Conservation Plan	Track location and amount of gravel emplacement	Hydromodification
Monitor effects of flow management strategies on side channels	Provide data on quality and quantity of side channel habitat at various flow conditions; quantify biological response	Quantify inlet/outlet elevations, map large woody debris, conduct snorkel and electrofishing surveys	Hydromodification
Monitor steelhead spawning and incubation	Evaluate the effects of released flows on steelhead spawning and egg incubation	Contribute funding to the Washington State Department of Fish and Wildlife and Muckleshoot Indian Tribe spawner surveys	Hydromodification
Monitor downstream migration of juvenile salmon	Identify changes in juvenile downstream migration patterns as a result of the Additional Water Storage Project	Install and operate screw trap at RM 34	Hydromodification

Study Name	Objective	Description	Factor of Decline Addressed
Monitor salmon spawning and incubation	Identify off-channel habitats used by salmon that are affected by an early refill schedule	Provide funding to the Washington State Department of Fish and Wildlife and the Muckleshoot Indian Tribe to expand spawning surveys to lateral habitats and restoration sites	Hydromodification
Monitor salmon redds and emergence	Evaluate the impact of early refill on salmon emergence and incubation	Provide funding to the Washington State Department of Fish and Wildlife and the Muckleshoot Indian Tribe to identify redds and monitor impacts of early refill using fry emergence traps	Hydromodification
Monitor distribution of woody debris	Provide data to facilitate evaluation of woody debris management program	Survey Green River from the diversion dam to Highway 18 to identify distribution and abundance of large woody debris	Hydromodification
Monitor distribution of sediments below Tacoma diversion dam	Provide data to facilitate evaluation of gravel nourishment program	Determine areal extent of gravel bars exposed at flows less than 300 cubic feet per second as measured at Auburn, and changes in bed elevation and channel capacity at selected cross-sections	Hydromodification

Green/Duwamish Ecosystem Restoration Project Studies

The Green/Duamish Ecosystem Restoration Project, described more fully in the Upper Green River subwatershed section, is a joint program between the U.S. Army Corps of Engineers and jurisdictions in WRIA 9. As part of this program, several studies will be conducted that will help guide the restoration projects. Table 15 below describes two such studies that will occur in the Middle Green River subwatershed.

Table 15. Middle Green River studies: Green/Duwamish Ecosystem Restoration Project.

Study Name	Objective	Description	Factor of Decline Addressed
Baseline biological evaluation	Estimate current fish populations	Utilize data from the RM 34 screw trap to: <ol style="list-style-type: none"> 1. Determine the location and timing of migratory fish on a reach scale 2. Estimate current fish populations to determine if the restoration projects are helpful at a population level 3. Provide information for ESA consultations needed for the large woody debris and gravel projects. 	None; fills data gap
Hydrologic and engineering management plan	Determine hydrologic and geomorphic constraints on and needs of the gravel and large woody debris projects	Develop a hydrologic model and conduct a geomorphic analysis of the mainstem Green River and its key tributaries	None; fills data gap



Lower Green River Subwatershed

Background

The Lower Green River subwatershed begins at RM 32 and extends 21 miles to RM 11, as shown in Figure 7. Springbrook Creek, Mullen Slough, and Mill Creek are the major tributaries to the Lower Green River. Historically, the White River, the Cedar/Black River and the Green River all joined in this reach to form a single large river, the Duwamish (See Figure 2 in Chapter 2). The White joined the Green near RM 31, and the Black River, which at the time also drained Lake Washington, joined the Green at RM 11. In 1906, a logjam diverted the flow of the White River to the Puyallup River, and shortly thereafter, this arrangement was permanently engineered. Diversion of the White River, a glacially fed stream originating on Mt. Rainier, meant that in addition to a significant loss of flow and sediment, summer flows in the Green were diminished by about half, since the Green is not glacier-fed. The Cedar/Black was diverted from the Green in 1916. Together, these diversions resulted in a reduction of drainage area of about 60 percent.

After the diversion of the White and the Cedar/Black River, large earthen levees were built along the Lower Green River to further protect the valley from flooding. About 80 percent of the river upstream from RM 17 has a levee or revetment on at least one bank. These levees and other land use changes have reduced the amount of habitat available to salmon in the Lower Green River subwatershed, particularly refuge habitats.

Residential development constitutes about half of the subwatershed area, with industrial and commercial development comprising an additional 27 percent. Mixed uses, parks, and agriculture comprise the remaining land uses. Jurisdictions located in the Lower Green River subwatershed include the cities of Algona, Auburn, Federal Way, Kent, Renton, SeaTac, and Tukwila, and unincorporated King County. Virtually all of the Lower Green River subwatershed is on the urban side of the urban growth area line (Figure 1). Additional population density is therefore anticipated for this area, and potential receiving sites for development rights transfers could be located in this subwatershed.

Fish Use

Currently the Lower Green River mainstem is used for upstream and downstream migration for all salmon species, including bull trout, that occur in the watershed. Historically, this reach was important for juvenile rearing, especially for chinook, chum, and pink salmon. It is assumed that rearing continues today but the extent of juvenile use is suspected to be limited due to severe hydromodification in this reach. Some spawning habitat for salmon is provided in the upper portions of this mainstem reach, although spawning and rearing are limited due to lack of gravel bars and riffles, shallow river margins, low velocity or off-channel areas, and cover.

The tributaries in the Lower Green River generally do not support chinook salmon spawning, but some support coho salmon and cutthroat trout. Some tributaries, especially near their mouths, may support juvenile rearing or refuge habitat for all species of salmon.

Factors of Decline and Strategy

Urbanization, water diversions, revetments, and levees have adversely affected salmon habitat in the Lower Green River. Dam flow manipulation and revetments and levees have lowered the river so that it wets only a portion of the former floodplain and has disconnected side-channels and off-channel habitat from the river. The armoring and simplification of the mainstem have resulted in a lack of instream habitat complexity, including a lack of large woody debris. Low flows have created barriers to adult salmon migration, and urbanization has led to chronic water quality problems and severely reduced riparian habitats and functions. Because floodwaters no longer annually recharge groundwater, cool summer groundwater flows to the river also are reduced.

Urbanization and other human activities also have negatively affected tributaries to the Lower Green River. Factors of decline in the tributaries include the loss of forest cover and an increase in impervious surfaces, leading to hydrologic disruptions to stream flow, channel degradation, and increased sedimentation. Roads contribute runoff and create fish passage barriers. Water quality in the tributaries is degraded, streams are channelized, and non-native species have invaded.

The WRIA 9 Strategy calls for actions to address these problems in the Lower Green River. Several factors are identified as important for restoring this reach, including protection of areas that provide critical habitat or have reasonable potential for improvement; connection of the mainstem with the floodplain, side, and off-channel habitat; rehabilitation and enhancement of habitat; and mainstem water quality. In tributaries, the Strategy recommends restoring access for adult and juvenile salmon. In addition, the WRIA 9 Strategy recommends studying juvenile salmon survival in the Lower Green River, including behavior, growth, survival rates, and habitat carrying capacity.

Near-Term Actions

Only one of the near-term actions is exclusive to the Lower Green River. A second action focuses on restoration and applies more broadly to the Lower Green River, Elliott Bay/Duwamish, and Nearshore subwatersheds. This broadly focused restoration action is described here and also is referenced in the other subwatershed sections. A third action, focused on restoration opportunities on agricultural lands, is similar to MG Action 2. Two study recommendations for the Lower Green River also have been identified. The actions described earlier in the WRIA-wide chapter of this document also apply and are meant to be implemented in this subwatershed.

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Figure 7. Lower Green River Subwatershed.

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LG Action 1: Incorporate recommendations that support salmon habitat needs into Mill Creek Reconnaissance and Action Plans developed in WRIA 9, with an emphasis on proposals that support juvenile chinook salmon rearing (to the extent practical within budget constraints and consistent with the goal of protecting agricultural lands).

King County is working together with Kent, Auburn, and other interested parties to generate a targeted set of projects, policies, and research recommendations to improve conditions for agricultural lands, flood plain management and conveyance, and fish habitat in the Mill Creek basin.¹⁶ The intent of the plan is to balance these sometimes-conflicting objectives. WRIA 9 recommends that the proposed actions incorporate salmon habitat restoration elements where possible and take care to not foreclose future fish-habitat restoration opportunities in the downstream portions of the basin. The downstream portions of Mill Creek and Mullen Slough present an opportunity for salmon refugia within an otherwise highly urbanized portion of the WRIA.

- **Benefit to salmon:** Including the needs of salmon as Reconnaissance and Action Plans are developed may help identify opportunities to protect, connect, or restore habitat that would otherwise go unidentified.
- **Link to Strategy:** Restore aquatic and riparian habitat within tributaries.
- **Implementation:** As basin planning efforts are scoped, inclusion of studies that focus on salmon should be considered.
- **Approximate cost:** Largely staff time.



LG Action 2: Restore Lower Green River, Elliott Bay/Duwamish, and Nearshore habitats.

The goal of this action is to identify restoration sites in the Lower Green River, Elliott Bay/Duwamish, and Nearshore subwatersheds. Several projects are already identified; those related to the Lower Green River include projects in the Green/Duwamish Ecosystem Restoration Project and sites targeted by the Green River Flood Control Zone District. Additional key restoration projects may need to be developed in this reach, as there is little in the way of off-channel habitat. LG Study 1, described below, would help in identifying key areas in which to create or enhance habitat. WW Action 15 will provide a process for identifying new restoration projects.

- **Benefit to salmon:** Restoring habitat in the Lower Green will support juvenile salmon rearing and migration.
- **Link to Strategy:** Restore aquatic habitat within the mainstem.
- **Implementation:** The WRIA will provide support to existing projects. WW Action 15 will develop a process to identify new projects. This action should be conducted within that process.
- **Approximate cost:** Varies by project.

¹⁶ It is anticipated that the Mill Creek Action Plan will identify data collection and research priorities for establishing long-term salmon conservation goals for the Mill Creek basin. The overall plan will contain the following types of recommendations: capital projects, ongoing maintenance, policies, research, and monitoring.



LG Action 3: Identify and pursue opportunities on agricultural lands to enhance or restore high quality salmon habitats while maintaining viable agriculture.

The intent of this action is to improve overall salmon habitat while preserving or enhancing agricultural opportunities. Agricultural activities within the Mill Creek basin (including Mullen Slough) occur adjacent to streams that provide refuge and rearing for salmonids. Currently deed restrictions and other public policies and regulations create limitations for salmon habitat restoration activities on agricultural lands, both on lands that are part of the Farmland Preservation Program (FPP) and on other lands. Restoration projects on FPP properties must be designed and installed in a manner that will ensure that the county's obligation to preserve the property for agricultural purposes remains intact. The Conservation Reserve Enhancement Program, a joint partnership between the State of Washington and the U.S. Department of Agriculture, is one opportunity to enhance salmon habitat through landowner incentives. King County should work with property owners to identify sites, particularly along Lower Mullen Slough and Lower Mill Creek, where habitat restoration projects could be pursued without compromising viable agricultural uses of the land.

- **Benefit to salmon:** Improving salmon habitat in the Mill Creek basin and Mullen Slough will enhance the rearing functions of these areas.
- **Link to Strategy:** Restore aquatic habitat.
- **Implementation:** King County should work with the agricultural community to pursue opportunities while maintaining viable agricultural use of the land.
- **Approximate cost:** Unknown, mostly staff costs.



LG Study 1: Conduct Lower Green River baseline habitat mapping.

This study will establish a baseline for monitoring of the Lower Green River. Physical habitat within the current active channel should be documented using available photographs and field surveys. A GIS basemap should be developed from the information to support long-term monitoring.

Protocols will be established for key habitat parameters and their measurement. These protocols will be carefully developed to maximize their ability to accurately reveal future habitat trends and to ensure consistency with other efforts in the watershed. For example, these protocols should mesh with the U.S. Army Corps of Engineers' baseline habitat mapping of the Middle Green River. At a minimum, this monitoring plan will specify data collection methodologies needed to develop the following information: a habitat unit map, pool frequency and area, large woody debris distribution, coarse and fine sediment distribution, and flow-related barriers to upstream fish passage. The data collected in this study and in EBD Study 1 will inform WW Action 1 and WW Action 3.

- **Benefit to salmon:** A better understanding of the distribution and quality of habitat in the Lower Green River will enable WRIA 9 to identify sites for protection and habitat restoration.
- **Link to Strategy:** Study to fill data gaps.
- **Implementation:** The WRIA 9 Technical Committee will oversee this project. King County will manage the day-to-day activities of this project.
- **Approximate cost:** \$50,000

LG Study 2: Establish a water-quality sampling site at River Mile 21.

This action would establish an additional water quality sampling site on the mainstem Green River, downstream of Mullen Slough, at approximately RM 21. Samples collected at the site would be analyzed for temperature, dissolved oxygen, total suspended solids, turbidity, and other water quality data important for salmon. The monitoring should occur over a period of five years.

- **Benefit to salmon:** The data gathered in this study will identify and help the WRIA address water quality problems in the Lower Green.
- **Link to Strategy:** Study to fill data gaps about habitat carrying capacity.
- **Implementation:** The WRIA 9 Technical Committee will oversee this work.
- **Approximate cost:** \$5,000

Summary of WRIA-Wide Near-Term Actions

The following near-term actions apply to each subwatershed in WRIA 9.

- WW Action 1: Develop an inventory of currently productive fish habitat in WRIA 9 based on the *Reconnaissance Assessment* and additional research, and identify the habitat-forming processes associated with that habitat.
- WW Action 2: Protect habitat and habitat-forming processes identified in WW Action 1 or where other efforts have identified important habitat.
- WW Action 3: Determine fish use and habitat priorities within jurisdictions.
- WW Action 4: Apply existing incentives (and where necessary, develop new incentives) for protection of salmon habitat in WRIA 9.
- WW Action 5: Identify existing educational and outreach materials for promoting salmon conservation messages and make them available for use by all on a website or on loan.
- WW Action 6: Encourage people to contribute personally to salmon conservation through high-visibility, enticing outreach efforts focused on the theme of lawn and garden care.
- WW Action 7: Improve enforcement of existing regulations that protect salmon and salmon habitat.
- WW Action 8: Evaluate adequacy of existing regulations to protect riparian buffers and improve them where necessary to maintain functions that protect fish habitat.
- WW Action 9: Promote the use of alternative shoreline protection techniques.
- WW Action 10: Evaluate and improve erosion and sediment control programs to reduce sediment entering salmon-bearing streams.
- WW Action 11: Adopt stormwater standards that protect salmon.
- WW Action 12: Develop programs and protocols for the maintenance of stormwater systems and facilities to reduce entry of sediment to salmon streams.
- WW Action 13: Review road maintenance practices and adopt written operating procedures to reduce potential impacts to salmon and other pollutants and salmon habitat.
- WW Action 14: Review parks and grounds maintenance procedures and adopt written best management practices that protect salmon and salmon habitat.
- WW Action 15: Develop a comprehensive, WRIA-wide process to identify, develop, and prioritize projects that benefit salmon and carry out the WRIA 9 Strategy.
- WW Action 16: Create combined naturalist and stewardship activities across WRIA 9.

- WW Action 17: Encourage the restoration of riparian buffers.
- WW Action 18: Implement Phase 1 of the Ecosystem Restoration Project.
- WW Action 19: Evaluate fish passage barriers at the local jurisdiction level.
- WW Study 1: Monitor habitat restoration projects to determine fish response and apply the information to future projects.
- WW Study 2: Identify which factors are limiting to salmon populations by subwatershed.
- WW Study 3: Develop a research framework for assessing juvenile salmon survival in WRIA 9.
- WW Study 4: Support the Green/Duwamish Water Quality Assessment.
- WW Study 5: Conduct an assessment of large woody debris recruitment in WRIA 9.
- WW Study 6: The WRIA 9 Planning Work Group, WRIA 9 Technical Committee, Central Puget Sound Water Suppliers Forum, and other appropriate agencies should work together to understand and evaluate the water budget for people and fish in the WRIA.
- WW Study 7: Develop mechanisms to increase collaboration and coordination in scientific work directed toward salmon recovery.

Current Efforts

Jurisdiction Efforts

Jurisdictions in the Lower Green River subwatershed are taking action to protect resources within the subwatershed. Since 1998, when the listing of chinook salmon was imminent, most jurisdictions in the Lower Green River subwatershed have examined their policies and practices with respect to salmon. Several jurisdictions have also expanded existing programs and initiated new programs and projects to improve awareness and lessen impacts to salmon. A sample of these new efforts follows:

- Auburn reduced new street widths from 32 feet to 28 feet, reducing impervious surface and associated stormwater runoff.
- In 2001, Auburn adopted standard operating procedures for spill response that are coordinated between the fire and public works departments. Algona relies on Auburn for spill response.
- Tukwila is developing an incentive program for landowners who voluntarily restore habitat.
- SeaTac and King County offer rebates of surface water management fees to private owners of stormwater facilities who document maintenance of their systems.
- Renton is developing a wetland mitigation bank along Springbrook Creek that will include riparian plantings.

- The Washington State Department of Ecology recognized Federal Way for its stormwater management efforts in 1998.
- Kent has a comprehensive water conservation program.

Appendix A provides more detail about the activities of jurisdictions to protect salmon resources in the WRIA.




Projects


The projects described below are those that benefit chinook salmon and possibly bull trout, and for which construction is planned to start in the next five years. All other identified projects are described in Appendix C.

Jurisdiction Projects

The jurisdictions in the Lower Green River subwatershed are planning to construct a variety of salmon habitat projects over the next five years, most of which are on tributaries that support coho salmon and cutthroat trout. Information about these projects is in Appendices A and C. Table 16 below describes projects that will benefit chinook salmon or bull trout.

Table 16. Lower Green River projects: WRIA jurisdictions.

Project Name and Status	Project Description	Benefits to Salmon	Factors of Decline Addressed	Strategy Elements Addressed	Jurisdiction
Nelson Place side channel  Status:	Reconnection of abandoned river channel to create side channel	Increases habitat complexity for all species	Hydro-modification	Connect mainstem with side channels	Tukwila
Gilliam Creek fish barrier removal  Status:	Retrofit existing 108-inch flap gate to allow fish passage	Opens up habitat for all species	Fish passage	Restore access to tributaries	Tukwila
West Hill Springs channel improvement  Status:	Reduce sediment loading to Mill Creek and improve habitat in spring area and tributary connection to Mill Creek	Improves water quality for chinook, chum, coho, cutthroat, and winter steelhead	Water quality	Protect habitat-forming processes	Auburn

Project Name and Status	Project Description	Benefits to Salmon	Factors of Decline Addressed	Strategy Elements Addressed	Jurisdiction
Central conveyance storage and water quality improvement  Status:	Two-phase study to map the flood plain of Mill Creek and determine how to manage future development. Involves acquisition and construction.	Improves water quality for chinook, chum, coho, cutthroat, and winter steelhead	Water quality	Protect habitat-forming processes	Auburn
Green River Natural Resources Area enhancement project Status: (on-going)	Multi-purpose stormwater management/ wetland enhancement/ wildlife and fisheries habitat project comprising 300 acres on Springbrook Creek	Improves water quality for chinook, chum, coho, cutthroat, and winter steelhead	Water quality, hydrology, riparian conditions, fish passage	Protect habitat-forming processes	Kent

Salmon Recovery Funding Board and King Conservation District Projects

WRIA 9 recommends projects for funding to two organizations: the Salmon Recovery Funding Board and the King Conservation District. The Salmon Recovery Funding Board is a state organization that disburses grants for salmon habitat projects. The WRIA 9 Steering Committee selects projects to send to the Salmon Recovery Funding Board for its consideration. Property owners in King County support the King Conservation District with a \$5-per-parcel annual fee. The King Conservation District devotes three-fifths of this fee from parcels within WRIA 9 to salmon, water quality, and flooding projects in WRIA 9. The WRIA 9 Forum approves projects to send to the King Conservation District Board for their consideration for this funding.

No projects in the Lower Green River subwatershed are currently planned using these funding sources.








Green River Flood Control Zone District Projects


The Green River Flood Control Zone District is an interjurisdictional flood hazard and resource management program. The District provides a funding source for the operation and maintenance of levees, revetments, and pump stations along the Lower Green River via the Green River Basin Program interlocal agreement between King County and the cities of Tukwila, Kent, Auburn, and Renton.

All Green River Flood Control Zone District levee and revetment projects are retrofitted using biostabilization design techniques that significantly improve in-stream salmon and riparian habitat. The projects also incorporate the maximum amount of facility setback possible, given physical site constraints, in order to achieve habitat restoration and flood hazard reduction.

Table 17 below describes the habitat elements of the eight projects that the Green River Flood Control Zone District plans to undertake over the next five years.

Table 17. Lower Green River projects: Green River Flood Control Zone District.

Project Name and Status	Project Description	Benefits to Salmon	Factors of Decline Addressed	Strategy Elements Addressed
Segale Levee (RM 15.4)  Status:	Restore in-stream and riparian habitat, replace non-native vegetation with native, reduce erosion, add large woody debris	Restores habitat complexity and function for all species	Riparian condition, sediment transport, hydromodification	Rehabilitate aquatic habitat in the mainstem
Desimone Levee (RM 15.4 to 15.6)  Status:	Restore in-stream and riparian habitat, replace non-native vegetation with native, reduce erosion, add large woody debris	Restores habitat complexity and function for all species	Riparian condition, sediment transport, hydromodification	Rehabilitate aquatic habitat in the mainstem
Boeing Levee (RM 17.7)  Status:	Restore in-stream and riparian habitat, replace non-native vegetation with native, reduce erosion, add large woody debris	Restores habitat complexity and function for all species	Riparian condition, sediment transport, hydromodification	Rehabilitate aquatic habitat in the mainstem
Fragar Road revetment (RM 18)  Status:	Restore in-stream and riparian habitat, replace non-native vegetation with native, reduce erosion, add large woody debris	Restores habitat complexity and function for all species	Riparian condition, sediment transport, hydromodification	Rehabilitate aquatic habitat in the mainstem
Narita Levee (RM 21.0 to 21.2)  Status:	Restore in-stream and riparian habitat, replace non-native vegetation with native, reduce erosion, add large woody debris	Restores habitat complexity and function for all species	Riparian condition, sediment transport, hydromodification	Rehabilitate aquatic habitat in the mainstem
Pipeline Levee (RM 21.9)  Status:	Restore in-stream and riparian habitat, replace non-native vegetation with native, reduce erosion, add large woody debris	Restores habitat complexity and function for all species	Riparian condition, sediment transport, hydromodification	Rehabilitate aquatic habitat in the mainstem
Lower Mullen Slough restoration (RM 23.8)  Status:	Create off-channel pools and refuge, restore riparian zone and adjacent wetlands, eradicate invasive plant species, and restore upland riparian area east of the slough	Restores habitat complexity and function for chinook and coho	Riparian condition, hydromodification, non-native species	Rehabilitate aquatic habitat in the tributaries




Project Name and Status	Project Description	Benefits to Salmon	Factors of Decline Addressed	Strategy Elements Addressed
Fenster Revetment (RM 32.0)  Status:	Reconnect mainstem to Pautski Slough, restore in-stream and riparian habitat, replace non-native vegetation with native, reduce erosion, add large woody debris	Provides access to flood refuge habitat, restores habitat complexity and function for all species	Riparian condition, sediment transport, hydromodification	Connect mainstem with floodplain habitat, rehabilitate aquatic habitat in the mainstem

Green/Duwamish Ecosystem Restoration Project

As described in the Upper Green River subwatershed section, the Green/Duwamish Ecosystem Restoration Project is a joint effort of the WRIA 9 jurisdictions and the U.S. Army Corps of Engineers. In Phase 1 of this program, 20 projects will be built in several subwatersheds of WRIA 9. Table 18 below describes the projects that benefit chinook salmon or bull trout that will be constructed in the Lower Green River subwatershed.

Note that the volunteer revegetation and large woody debris placement projects described in Table 11, Middle Green River projects, and the water quality studies described in Table 6, Upper Green River studies, will be carried out in the Lower Green River subwatershed.

Table 18. Lower Green River projects: Green/Duwamish Ecosystem Restoration Project.

Project Name and Status	Project Description	Benefit to Salmon	Factors of Decline Addressed	Strategy Element Addressed
Green River Park (RM 24)  Status:	Construct 600-foot backwater slough	Creates off-channel habitat for all species	Hydromodification, riparian condition	Connect mainstem with floodplain habitat
Horsehead Bend (RM 26)  Status:	Excavate 1300-foot side channel along the alignment of an old river channel	Creates side-channel habitat for all species	Hydromodification, riparian condition	Connect mainstem with side-channel habitat
Mainstem Maintenance (Boeing and Fenster sites)  Status:	Construct bioengineering alternatives to bank stabilization and relocate the bank landward of its present location where possible	Increase habitat complexity and quality for all species	Hydromodification, riparian condition	Rehabilitate aquatic habitat in the mainstem

Studies

Jurisdiction Studies

Jurisdictions in the Lower Green River subwatershed collect data that will help them to make better management decisions. Table 19 below describes one such study that will collect data about salmon use of the Lower Green River.

Table 19. Lower Green River study: WRIA jurisdictions.

Study Name	Objective	Project Description	Factors of Decline Addressed	Jurisdiction and Partners
Black River smolt counts	Determine extent of smolt usage of Springbrook Creek	Smolt counter in Black River Pump station counts smolts in Springbrook Creek	Fish passage	Kent (lead), King County, Renton

Green River Flood Control Zone District Studies

The Green River Flood Control Zone District, described above under Projects, conducts monitoring of its habitat projects to determine the effectiveness of project design elements. Table 20 below describes this effort.

Table 20. Lower Green River study: Green River Flood Control Zone District.

Study Name	Objective	Project Description	Factors of Decline Addressed
Green River Bank Stabilization Project Monitoring	Evaluate the effectiveness of mitigation elements of recent and upcoming bank stabilization projects	Includes vegetation, large woody debris and juvenile salmonid monitoring at several project sites on the lower Green River	Rehabilitate aquatic habitat in the mainstem



Elliott Bay/Duwamish Subwatershed

Background

The Duwamish estuary begins at RM 11, at the upper limit of tidal influence and the confluence of the Black River with the Green River (Figure 8). The Duwamish River flows past scattered urban parks and single- and multi-family residences, as well as scores of industrial and commercial sites, on its way to Elliott Bay. The upper portion of the Duwamish has been diked and leveed, while the lower Duwamish industrial area has been dredged and filled. As a result, the Duwamish has lost 100 percent of its tidal swamps and 97 percent of its marshes. Docks and piers line Elliott Bay, and both the bay and estuary are extensively armored.

Industrial (43 percent) and residential (39 percent) development is the primary land use in the Elliott Bay/Duwamish subwatershed. The subwatershed is primarily urban in character and includes the cities of Tukwila and Seattle. All of the Elliott Bay/Duwamish subwatershed is on the urban side of the urban growth area line (Figure 1). Additional population density is therefore anticipated for this area, and potential receiving sites for development rights transfers could be located in this subwatershed.

Fish Use

The Duwamish estuary provides a vital link in anadromous salmon life cycles. Juveniles of all species rear, take refuge, and acclimate to salt water in the Duwamish. In particular, chinook and chum salmon are known to depend upon estuaries. Native char (bull trout/Dolly Varden) adults and subadults have been observed in the Duwamish. Adult anadromous salmon use the Duwamish River to transition back to fresh water and to migrate to freshwater spawning areas.

Factors of Decline and Strategy

Urban and industrial development has taken its toll on the Elliott Bay/Duwamish. Factors of decline in this subwatershed include the loss of the swamps, marshes, and tidal mudflats that once formed the estuary, simplification of the channel, degradation of riparian functions, and pollution of water and sediment. In the tributaries, urbanization has led to fish passage barriers, small patches of disconnected marginal habitat, altered hydrology and channel stability, and reduced water quality.

The WRIA 9 Strategy emphasizes the importance of ensuring juvenile salmon survival in the Lower Green River, Elliott Bay/Duwamish, and Nearshore subwatersheds. In the near term, the Strategy calls for studies of juvenile salmon survival aimed at determining whether a bottleneck exists in these subwatersheds. The Strategy also recommends protecting habitats that are suitable for restoration or are functioning well, reconnecting the mainstem with the floodplain

Figure 8. Elliott Bay/Duwamish Subwatershed.

8 ½ x 11 b&w

and side channels, and removing fish passage barriers in the larger tributaries. In addition, the Strategy identifies a number of types of restoration projects for the Elliott Bay/Duwamish subwatershed, including recreating intertidal habitat by moving back banks, reducing slopes, and excavating filled areas to restore tidal circulation. The Strategy also calls for enhancing habitat quality by softening shorelines, establishing conditions for deposition of sediment and organic matter, and increasing areas of marsh and riparian vegetation.

Near-Term Actions

The following near-term action for the Elliott Bay/Duwamish subwatershed supplements those that apply to the entire WRIA.



EBD Action 1: Restore Elliott Bay/Duwamish, Nearshore, and Lower Green River habitats.

A wide variety of restoration projects already are in the planning stages for sites in the Elliott Bay/Duwamish subwatershed. WRIA 9 should support these projects as appropriate and feasible. EBD Study 1, described below, would help in identifying key areas in which to create or enhance habitat. The juvenile salmon survival framework (see WW Study 3), once developed, may point to new restoration actions that could be pursued. WW Action 15 will provide a process for identifying new restoration projects.

- **Benefit to salmon:** Restoring of habitat in the Duwamish will provide vital support to juveniles as they transition from fresh to salt water.
- **Link to Strategy:** Restore and/or increase habitat area.
- **Implementation:** The WRIA will provide support to existing projects. WW Action 15 will develop a process to identify new projects. This action should be conducted within that process.
- **Approximate cost:** Varies by project.



EBD Study 1: Conduct baseline habitat mapping in the Elliott Bay/Duwamish subwatershed.

This study, in combination with LG Study 1, will establish a baseline for monitoring of the Lower Green River, the Duwamish, and Elliott Bay. Physical habitat within the current active channel will be documented using available photographs and field surveys. A GIS basemap will be developed from the information to support long-term monitoring.

Protocols will be established for key habitat parameters and their measurement. These protocols will be carefully developed to maximize their ability to accurately reveal future habitat trends and to ensure consistency with

- **Benefit to salmon:** A better understanding of the distribution and quality of habitat in Elliott Bay will enable WRIA 9 to identify sites for protection and habitat restoration.
- **Link to Strategy:** Study to fill data gaps.
- **Implementation:** The WRIA 9 Technical Committee will oversee this project. King County will manage the day-to-day activities of this project.
- **Approximate cost:** \$50,000

other efforts in the watershed. For example, these protocols should mesh with the U.S. Army Corps of Engineers' baseline habitat mapping of the Middle Green River. At a minimum this monitoring plan should specify data collection methods needed to develop the following information: a habitat unit map, pool frequency and area, large woody debris distribution, coarse and fine sediment distribution, and flow-related barriers to upstream fish passage. The data collected in this study and in LG Study 1 will inform WW Action 1 and WW Action 3.

Summary of WRIA-Wide Near-Term Actions

The following near-term actions apply to each subwatershed in WRIA 9.

- WW Action 1: Develop an inventory of currently productive fish habitat in WRIA 9 based on the *Reconnaissance Assessment* and additional research, and identify the habitat-forming processes associated with that habitat.
- WW Action 2: Protect habitat and habitat-forming processes identified in WW Action 1 or where other efforts have identified important habitat.
- WW Action 3: Determine fish use and habitat priorities within jurisdictions.
- WW Action 4: Apply existing incentives (and where necessary, develop new incentives) for protection of salmon habitat in WRIA 9.
- WW Action 5: Identify existing educational and outreach materials for promoting salmon conservation messages and make them available for use by all on a website or on loan.
- WW Action 6: Encourage people to contribute personally to salmon conservation through high-visibility, enticing outreach efforts focused on the theme of lawn and garden care.
- WW Action 7: Improve enforcement of existing regulations that protect salmon and salmon habitat.
- WW Action 8: Evaluate adequacy of existing regulations to protect riparian buffers and improve them where necessary to maintain functions that protect fish habitat.
- WW Action 9: Promote the use of alternative shoreline protection techniques.
- WW Action 10: Evaluate and improve erosion and sediment control programs to reduce sediment entering salmon-bearing streams.
- WW Action 11: Adopt stormwater standards that protect salmon.
- WW Action 12: Develop programs and protocols for the maintenance of stormwater systems and facilities to reduce entry of sediment to salmon streams.
- WW Action 13: Review road maintenance practices and adopt written operating procedures to reduce potential impacts to salmon and other pollutants and salmon habitat.
- WW Action 14: Review parks and grounds maintenance procedures and adopt written best management practices that protect salmon and salmon habitat.
- WW Action 15: Develop a comprehensive, WRIA-wide process to identify, develop, and prioritize projects that benefit salmon and carry out the WRIA 9 Strategy.
- WW Action 16: Create combined naturalist and stewardship activities across WRIA 9.
- WW Action 17: Encourage the restoration of riparian buffers.
- WW Action 18: Implement Phase 1 of the Ecosystem Restoration Project.
- WW Action 19: Evaluate fish passage barriers at the local jurisdiction level.
- WW Study 1: Monitor habitat restoration projects to determine fish response and apply the information to future projects.
- WW Study 2: Identify which factors are limiting to salmon populations by subwatershed.

- WW Study 3: Develop a research framework for assessing juvenile salmon survival in WRIA 9.
- WW Study 4: Support the Green/Duwamish Water Quality Assessment.
- WW Study 5: Conduct an assessment of large woody debris recruitment in WRIA 9.
- WW Study 6: The WRIA 9 Planning Work Group, WRIA 9 Technical Committee, Central Puget Sound Water Suppliers Forum, and other appropriate agencies should work together to understand and evaluate the water budget for people and fish in the WRIA.
- WW Study 7: Develop mechanisms to increase collaboration and coordination in scientific work directed toward salmon recovery.

Current Efforts

Jurisdiction Efforts

Jurisdictions are acting to protect the Elliott Bay/Duwamish and its tributaries. Tukwila offers a program to help educate citizens on salmon-friendly gardening choices. The city also has participated in and helped organize volunteer activities such as Salmon in the Classroom, planting projects, and storm drain stenciling. Seattle has staff members with special expertise, including a fish biologist and a site inspection team, who work with developers as they respond to salmon conservation issues before development occurs, in order to flag and address any potential issues. A variety of incentives are available to private landowners to transfer development from rural areas in exchange for additional building height in the City of Seattle and to those who wish to reduce water consumption. Seattle also recently published its *Urban Blueprint* (2001), which sets forth the scientific framework under which the city will develop capital projects and evaluate programs and policies to support salmon recovery. More information about these activities is in Appendix A.

Non-Profit and Other Stakeholder Programs







The Port of Seattle owns and operates a wide variety of facilities in the Duwamish and Elliott Bay. As part of its Harbor Redevelopment Strategy, the Port designs its projects so that they limit overwater coverage, limit existing sources of contamination, and use inert construction materials. The Port has developed 10 environmental guidelines as part of its strategy, including maximization of environmental benefits and processes, improvement of Duwamish estuary habitats and fisheries, and evaluation of cumulative effects.

Projects

Jurisdiction Projects

Jurisdictions are acting to protect and restore habitat in the Duwamish and Elliott Bay. The projects described below in Table 21 provide benefit to chinook salmon or bull trout.

Table 21. Elliott Bay/Duwamish projects: WRIA jurisdictions.


Project Name and Status	Project Description	Benefit to Salmon	Factors of Decline Addressed	Jurisdiction and Partners
Spokane St. bridge public access site  Status:	Lay back shoreline to create more shallow habitat at upper and middle tidal elevations	Creates rearing habitat for all species	Loss of habitat in migratory corridor	Seattle (lead), Port of Seattle, and King County
Georgetown pump station  Status:	Create intertidal habitat focused on upper and middle tidal elevations	Creates rearing habitat for all species	Loss of habitat in migratory corridor	Seattle (lead) and possibly the U.S. Army Corps of Engineers
1 st Ave. Southbridge site  Status:	Create intertidal habitat focused on upper and middle tidal elevations	Creates rearing habitat for all species	Loss of habitat in migratory corridor	Seattle (lead) and possibly the U.S. Army Corps of Engineers and the Washington State Department of Transportation
City Light South  Status:	Restore the upper and middle intertidal zones through regrading of the shoreline and riparian plantings.	Creates rearing habitat for all species	Loss of habitat in the migratory corridor	Seattle
Duwamish Waterway Park  Status:	Restore approximately 0.5 acre of intertidal mudflats and surround with native plantings	Creates rearing habitat for all species	Loss of habitat in the migratory corridor	King County (lead), U.S. Army Corps of Engineers
Codiga Farms side channel  Status:	Construction of side channel and inter-tidal marsh	Creates rearing habitat for all species	Loss of habitat in the migratory corridor	Tukwila (lead), U.S. Army Corps of Engineers

Salmon Recovery Funding Board and King Conservation District Projects

WRIA 9 recommends projects for funding to two organizations: the Salmon Recovery Funding Board and the King Conservation District. The Salmon Recovery Funding Board is a state organization that disburses grants for salmon habitat projects. The WRIA 9 Steering Committee selects projects to send to the Salmon Recovery Funding Board for its consideration. Property owners in King County support the King Conservation District with a \$5-per-parcel annual fee. The King Conservation District devotes three-fifths of this fee from parcels within WRIA 9 to salmon, water quality, and flooding projects in WRIA 9. The WRIA 9 Forum approves projects to send to the King Conservation District Board for its consideration for this funding.

One project in the Elliott Bay/Duwamish subwatershed, developed by the Environmental Coalition of South Seattle, was submitted for funding in the 2001 Salmon Recovery Funding Board grant process. (In April 2002, the Salmon Recovery Funding Board decided not to fund this project.) Table 22 below describes it briefly.



Table 22. Elliott Bay/Duwamish project proposed for funding by the Salmon Recovery Funding Board.


Project Name and Status	Project Description	Benefits to Salmon	Factors of Decline Addressed	Strategy Elements Addressed	Funding Source
Duwamish River revival  Status:	Expand intertidal habitat	Provides rearing habitat for all species	Loss of habitat in the migratory corridor	Increase habitat area	Salmon Recovery Funding Board (not funded)

Non-Profit and Other Stakeholder Projects

Non-profit groups and other stakeholders are active in the Elliott Bay/Duwamish subwatershed. Table 23 below describes planned projects in the subwatershed.

Table 23. Elliott Bay/Duwamish projects: Non-profit organizations and other stakeholders.




Project Name and Status	Project Description	Benefit to Salmon	Factors of Decline Addressed	Strategy Element Addressed	Lead Agency and Partners
GSA Marsh, Hamm Creek, Puget Creek, Terminal 105, Turning Basin  Status:	Provide upkeep, stewardship and monitoring for these restoration projects in the Duwamish Estuary	Maintains rearing habitat for all species	Loss of habitat in the migratory corridor, non-native species, alteration of habitat-forming processes	Increase habitat quality	People for Puget Sound (lead) and the U.S. Army Corps of Engineers, Elliott Bay/Duwamish Restoration Panel, King County, Earth Corps, Earth Ministry, Environmental Coalition of South Seattle, I'M A PAL Foundation
LaFarge site  Status:	Create an intertidal slough with restoration of the upper and middle intertidal habitats	Creates rearing habitat for all species	Loss of habitat in the migratory corridor	Increase habitat area	Port of Seattle

Project Name and Status	Project Description	Benefit to Salmon	Factors of Decline Addressed	Strategy Element Addressed	Lead Agency and Partners
Terminal 105 shoreline Status: 	Increase upper and middle intertidal habitats	Creates rearing habitat for all species	Loss of habitat in the migratory corridor	Increase habitat area	Port of Seattle

Elliott Bay/Duwamish Restoration Panel Projects

A 1991 consent decree settled a federal lawsuit against Seattle and Metro (now merged with King County) over contamination of the Duwamish and Elliott Bay by stormwater and combined sewer overflow, and established the Elliott Bay/Duwamish Restoration Panel. Participating agencies include the National Oceanographic and Atmospheric Administration – National Marine Fisheries Service, the U.S. Fish and Wildlife Service, the Muckleshoot Indian Tribe, the Suquamish Tribe, the Washington State Department of Ecology, the City of Seattle, and King County (Metro). The program is not intended to remedy all injuries; rather, it is intended to maximize benefits to the area's natural resources. Using \$24 million from Seattle and King County, the Panel funds, oversees, and monitors sediment remediation (\$12 million), habitat development (\$10 million), and pollution source-control projects (\$2 million). Several of these projects already are complete, and several will be constructed over the next few years. Table 24 below briefly describes future projects.

Table 24. Elliott Bay/Duwamish projects: Elliott Bay/Duwamish Restoration Panel.



Project Name and Status	Project Description	Benefit to Salmon	Factors of Decline Addressed	Strategy Elements Addressed
Duwamish/Diagonal combined sewer overflow and storm drain remediation project Status: 	Preferred plan is to dredge away three layers of contamination and backfill to grade with sand	Cleans up contaminated food sources for all species	Sediment quality, water quality	Increase habitat quality
Cecil B. Moses Park (North Winds weir) Status: 	Construct 1.03-acre intertidal basin with connection to the Duwamish on a 3.1 acre site owned by King County Parks	Creates rearing habitat for all species	Loss of habitat in the migratory corridor	Increase habitat area
Kenco Marine Status: 	Restore upper and middle intertidal habitat areas	Create rearing habitat for all species	Loss of habitat in the migratory corridor	Increase habitat area

Green/Duwamish Ecosystem Restoration Project

As described in the Upper Green River subwatershed section, the Green/Duwamish Ecosystem Restoration Project is a joint effort of the WRIA 9 jurisdictions and the U.S. Army Corps of Engineers. In Phase 1 of this program, 20 projects will be built in several subwatersheds of WRIA 9. Table 25 below describes the projects that benefit chinook salmon and bull trout that will be constructed in the Elliott Bay/Duwamish subwatershed.

Note that the volunteer revegetation and possibly the large woody debris placement projects described in Table 11, Middle Green River projects and the water quality studies described in Table 6, Upper Green River studies, will be carried out in the Elliott Bay/Duwamish subwatershed.

Table 25. Elliott Bay/Duwamish projects: Green/Duwamish Ecosystem Restoration Project.

Project Name and Status	Project Description	Benefit to Salmon	Factors of Decline Addressed	Strategy Element Addressed
Site One Duwamish Status: 	Construct intertidal marsh	Creates rearing habitat	Loss of habitat in the migratory corridor	Increase habitat area
Riverton Creek restoration Status: 	Plant riparian corridors, place large woody debris in the stream, remove the flap gate at the mouth	Opens up and improves habitat for all species	Hydro-modification, fish passage	Restore access to tributaries

The Site One Duwamish project is underway. Property acquisition was funded by the state Salmon Recovery Funding Board in 2000. These funds helped leverage additional monies including grants from the following sources:

- Washington State Department of Natural Resources Aquatic Lands Enhancement Account (ALEA)
- Elliott Bay/Duwamish Restoration Panel
- City of Seattle
- City of Tukwila
- King County.

Acquisition of the restoration site property was completed in September 2001. Restoration of the site is a Phase 1 project of the Ecosystem Restoration Project.

Studies*Jurisdiction Studies*

The City of Seattle is collecting water quality data in the South Park area of the Duwamish. Table 26 below briefly describes this effort.

Table 26. Elliott Bay/Duwamish studies: WRIA jurisdictions.

Study Name	Objective	Description	Factor of Decline Addressed	Jurisdiction and Partners
South Park water quality study	Assess water quality issues associated with stormwater in South Park	Study is still being developed	Water quality	City of Seattle

Non-Profit and Other Stakeholder Studies

Other organizations are active in the Elliott Bay/Duwamish subwatershed. In particular, the Port of Seattle plans to conduct several studies to increase knowledge of salmon habitat and health in the subwatershed. Table 27 below describes these studies.

Table 27. Elliott Bay/Duwamish studies: Non-profit organizations and other stakeholders.

Study Name	Objective	Description	Factor of Decline Addressed	Lead Agency and Partners
Bull trout assessment	Evaluate bull trout, identify juvenile and adult distribution and presence	Consultants perform fish presence/absence surveys	Fills data gap	Port of Seattle (lead) and U.S. Fish and Wildlife Service
Salmon toxicity	Determine immunological effects of exposure to PAHs and PCBs	Expose juvenile hatchery fish to PAHs and PCBs, analyze immunological response	Sediment quality	Port of Seattle, City of Seattle, King County, The Boeing Company
Chinook residence time in Elliott Bay and the Duwamish	Add precision to and complement existing work on juvenile residence time	Mark and recapture study, still developing details	Fills data gap	Port of Seattle
Nearshore and estuarine epibenthic productivity, juvenile salmon presence	Determine epibenthic productivity, presence and distribution of juvenile fish	Linked with East Waterway project, epibenthic samples taken with suction pumps, fish studied with beach seines	Fills data gap	Port of Seattle
Sediment sampling in the East Waterway	Fully characterize contamination and match against state sediment quality criteria	Take and analyze samples in East Waterway	Water quality	Port of Seattle

Lower Duwamish Superfund Program Studies

The Lower Duwamish Superfund Program is a federal and state cleanup action for contaminated sediments along the lower Duwamish Waterway. The Superfund study area extends from just south of the Turning Basin (near the Norfolk combined sewer overflow) to the south end of Harbor Island. The project is only for contaminated sediments and does not address upland sites, water quality, or any other issues associated with the river unless directly related to sediment contamination. Currently, the project is in its first stage, a Phase 1 remedial investigation to use existing data to determine the extent of contamination, assess human and ecological risk, and identify candidate sites for early cleanup actions. The second phase will include sampling to fill data gaps, conducting a baseline human health and ecological risk assessment, and setting cleanup levels for contaminated sediments. It will identify additional areas that need to be cleaned up to achieve acceptable levels of risk to human health and the ecosystem and evaluate cleanup options. A document called a record of decision will set cleanup levels and provide a cleanup plan for areas needing cleanup that have not been addressed by the early cleanup actions. The additional projects will be constructed in the final phase. The Environmental Protection Agency and the Washington State Department of Ecology provide oversight for the project, while King County, Seattle, the Port of Seattle, and Boeing are voluntary partners for Phase 1. Table 28 below briefly describes the studies that will be conducted during Phase 1.

Table 28. Elliott Bay/Duwamish studies: Lower Duwamish Superfund Program.

Study Name	Objective	Description	Factor of Decline Addressed
Site characterization and risk assessment	Characterize sediment problems, define exposure, and identify risk to humans and the ecosystem	Collect all available data, assess risk, and identify options for bringing risk down to acceptable levels	Sediment quality
Fill data gaps	Complete the site characterization	Fill data gaps identified in site characterization study	Sediment quality
Feasibility study	Determine which of suite of options are feasible	Analyze options to cleanup contaminated sediments identified in the Site Characterization and Risk Assessment	Sediment quality

Elliott Bay/Duwamish Restoration Panel Studies

As described above in the Projects section, the Elliott Bay/Duwamish Restoration Panel is a cooperative intergovernmental effort to rectify sediment contamination and restore habitat in Elliott Bay/Duwamish. Table 29 below briefly describes studies and monitoring efforts associated with the Panel's work.

Table 29. Elliott Bay/Duwamish studies: Elliott Bay/Duwamish Restoration Panel.

Study Name	Objective	Description	Factor of Decline Addressed
Monitoring of Pier 53-55 sediment remediation project	Determine effectiveness of remediation pilot project	Sample top two centimeters of sediment to evaluate chemical characteristics of recently deposited material, and top 10 centimeters to evaluate entire biologically active zone	Water quality, sediment quality
Monitoring of Norfolk combined sewer overflow sediment remediation project	Establish baseline sediment conditions of the backfill shortly after placement, and evaluate chemical characteristics of the backfill over 5-year timeframe	Sample top two centimeters of sediment to evaluate chemical characteristics of recently deposited material, and top 10 centimeters to evaluate entire biologically active zone; repeat at 4 stations each year through 2004	Sediment quality
Monitoring of habitat restoration sites	Determine if restoration sites gradually take on the characteristics of less disturbed reference sites	Monitor sites on a variety of parameters and compare those parameters to the performance of reference sites	Habitat degradation

Green/Duwamish Ecosystem Restoration Project Studies

As described in the Upper Green River subwatershed section, the Green/Duwamish Ecosystem Restoration Project is a joint effort of the WRIA 9 jurisdictions and the U.S. Army Corps of Engineers. In Phase 1 of this program, 20 projects will be built in several subwatersheds of WRIA 9, and several studies will be conducted to help guide the projects. Table 30 below describes the study that will be conducted in the Elliott Bay/Duwamish subwatershed.

Table 30. Elliott Bay/Duwamish study: Green/Duwamish Ecosystem Restoration Project.

Study Name	Objective	Description	Factor of Decline Addressed
Juvenile residency in the estuary	Increase knowledge of juvenile presence in estuary	Provide information about what habitats and locations are beneficial for juveniles, and whether juveniles increase in size and weight during their residency	Study to fill data gaps



Nearshore Subwatershed

Background

The Nearshore subwatershed encompasses the Puget Sound shoreline of mainland WRIA 9, the streams that drain directly to Puget Sound, and Vashon/Maury Island (Figure 9). The northern boundary of the Nearshore subwatershed is West Point in the City of Seattle, and the southern boundary is just north of Dumas Bay in the City of Federal Way. Its seaward boundary is the outer limit of the photic zone (approximately –30m mean lower low water), or the depth beyond which there is sufficient sunlight for active photosynthesis. The nearshore environment extends landward to include coastal landforms such as bluffs, sand spits, and coastal wetlands, as well as any marine riparian vegetation on or adjacent to these areas.

Residential development (68 percent) and industry (10 percent) are the primary land uses on the mainland portion of the Nearshore subwatershed. Residential development accounts for 92 percent of lands on Vashon/Maury Island. Most of the mainland portion of the subwatershed is incorporated into the cities of Seattle, Burien, SeaTac, Normandy Park, Des Moines, and Federal Way. Vashon/Maury Island remains unincorporated. The Nearshore subwatershed, with the exception of Vashon/Maury Island, is on the urban side of the urban growth area line (Figure 1). Additional population density is therefore anticipated for most of this area, and potential receiving sites for development rights transfers could be located in most of this subwatershed.

Several state and local parks provide public access to Puget Sound, including Seahurst Park in Burien, Lincoln Park in Seattle, and Saltwater State Park in Des Moines. Much of the shoreline has been modified to accommodate residential and commercial development. For example, 75 percent of the mainland shoreline, 84 percent of the Elliott Bay shoreline, and 50 percent of the Vashon/Maury Island shoreline have some form of shoreline armoring. An average of 64 percent of the shoreline in the subwatershed is armored.

Fish Use

All species of anadromous salmon use the nearshore for migration. However, the nearshore also is critical to juvenile salmon, especially chinook and chum salmon, for rearing, refuge from predators, and transition to saltwater habitats. Chinook salmon have been observed in Judd Creek on Vashon. Some chinook salmon (primarily from hatcheries) remain in Puget Sound for their entire adult life. Coho salmon spawn in tributaries to Puget Sound such as Miller and Des Moines creeks.

Figure 9. Nearshore Subwatershed.

8 1/2x11 b&w

Factors of Decline and Strategy

Historic and current land use practices, especially those related to residential, commercial, and industrial development, have degraded nearshore habitats, interrupted habitat-forming processes, degraded water and sediment quality, decreased riparian functions, and introduced non-native species. In the tributaries, land use practices have created fish passage barriers, caused chronic water quality problems, reduced large woody debris, simplified channels, and severely reduced riparian functions.

Placement of bulkheads and armoring in the marine shoreline has filled habitats and disrupted habitat-forming processes, altering nearshore sand and gravel movement. Eelgrass habitat, an important nursery for juvenile salmon, has become increasingly scarce. Development practices have removed riparian vegetation from the nearshore, decreasing insect and leaf input and destabilizing bluffs. Small near-shore streams, historically offering habitat for salmon, frequently have been affected by flow blockages and changes in land use that increase high winter flows, decrease low summer flows, and cause sedimentation of gravel spawning and rearing substrates.

For the Nearshore subwatershed, the WRIA 9 Strategy recommends protecting currently functioning habitat or habitat with reasonable restoration potential, and rehabilitating critical damaged habitat and habitat-forming processes, including sediment transport. Connecting upland areas to shorelines and intertidal areas and restoring access to and within tributary streams are also recommended. Another important Strategy emphasis is to fill data gaps through studies to evaluate high salmon use areas, habitat preferences, and utilization of nearshore environments, focusing on listed species first. Studies that focus on improving rehabilitation designs and how human modifications affect salmon utilization are also recommended.

Near-Term Actions

WRIA 9 proposes to conduct several actions and studies in the Nearshore subwatershed. The actions described earlier in the WRIA-wide chapter of this document also apply and are meant to be implemented in the Nearshore subwatershed.



NS Action 1: Restore Nearshore, Elliott Bay/Duwamish, and Lower Green River habitats.

Several restoration projects already are planned in the Nearshore subwatershed, including the removal of part of the gabion wall at Seahurst Park. Jurisdictions may identify other projects in the next few years. The WRIA will support those agencies undertaking these projects and also will work to identify additional projects. NS Action 2 and NS Study 1, described below, would help in identifying key areas in which to create or enhance habitat. WW Action 15 will provide a process for identifying new projects.

Attention to salmon friendly design is encouraged in projects involving the restoration and replacement of artificially armored shoreline or seawalls. Example projects could include the seawall restoration as part of the Alaskan Way viaduct project and the shoreline work associated with the Seattle Art Museum sculpture garden and expansion of Myrtle Edwards Park.

- **Benefit to salmon:** Restoration projects would provide a variety of benefits for fish, including good rearing and refuge habitat.
- **Link to Strategy:** Connect upland areas to shorelines and shorelines to intertidal areas.
- **Implementation:** The WRIA will provide support to existing projects. WW Action 15 will develop a process to identify new projects. This action should be conducted within that process.
- **Approximate cost:** Varies by project.



NS Action 2: Support the Puget Sound Nearshore Ecosystem Restoration Project, Phase 1.

The U.S. Army Corps of Engineers has undertaken a program to evaluate nearshore habitat, fill existing data gaps, and develop a list of nearshore acquisition and restoration projects. Called the Puget Sound Nearshore Ecosystem Restoration Project, this program will cover Puget Sound south of the Canadian border, including Hood Canal. Because of its regional scope, the Washington State Department of Fish and Wildlife is the lead non-federal sponsor. A sampling of other local sponsors includes Island County, Kitsap County, King County, Pierce County, the Washington State Department of Ecology, the Washington State Department of Natural Resources, the Puget Sound Action Team, the Northwest Straits Commission, and the Salmon Recovery Funding Board. The program is expected to last six years and cost \$12 million.

The ultimate outcome will be a list of acquisition and restoration projects that spans Puget Sound. Interim products will include a limiting factors analysis, a list of criteria to guide early action projects, and studies to fill identified data gaps. These products would be extremely useful to WRIA 9, enabling it to

- **Benefit to salmon:** The program will provide information and evaluation tools that will allow the WRIA to focus its resources effectively, resulting in better projects for salmon.
- **Link to Strategy:** Studies to fill data gaps.
- **Implementation:** The WRIA 9 Forum will decide annually upon the level of its financial contribution.
- **Approximate cost:** The WRIA 9 Forum will contribute \$50,000 in 2002 and will make future funding decisions in the context of its annual budget.

make better decisions regarding restoration of its nearshore habitats. The WRIA should continue to support this project financially. Support and participation from the WRIA as a whole will help ensure that the project moves forward.

NS Study 1: Conduct Nearshore habitat baseline mapping.

The *Habitat Limiting Factors and Reconnaissance Assessment* report and the *Reconnaissance Assessment of the State of the Nearshore Ecosystem* report both identified lack of detailed habitat information as a major data gap in the Nearshore subwatershed. This study will map salmon habitat in tidal areas of WRIA 9 in order to establish baseline conditions and will include an inventory of feeder bluffs and other beach-feeding areas.

- **Benefit to salmon:** This information will allow the WRIA to identify areas for protection and restoration.
- **Link to Strategy:** Study to fill data gaps.
- **Implementation:** The WRIA 9 Technical Committee will oversee this project, with support from interested local jurisdictions. The City of Seattle may manage it.
- **Approximate cost:** \$40,000

Summary of WRIA-Wide Near-Term Actions

The following near-term actions apply to each subwatershed in WRIA 9.

- WW Action 1: Develop an inventory of currently productive fish habitat in WRIA 9 based on the *Reconnaissance Assessment* and additional research, and identify the habitat-forming processes associated with that habitat.
- WW Action 2: Protect habitat and habitat-forming processes identified in WW Action 1 or where other efforts have identified important habitat.
- WW Action 3: Determine fish use and habitat priorities within jurisdictions.
- WW Action 4: Apply existing incentives (and where necessary, develop new incentives) for protection of salmon habitat in WRIA 9.
- WW Action 5: Identify existing educational and outreach materials for promoting salmon conservation messages and make them available for use by all on a website or on loan.
- WW Action 6: Encourage people to contribute personally to salmon conservation through high-visibility, enticing outreach efforts focused on the theme of lawn and garden care.
- WW Action 7: Improve enforcement of existing regulations that protect salmon and salmon habitat.
- WW Action 8: Evaluate adequacy of existing regulations to protect riparian buffers and improve them where necessary to maintain functions that protect fish habitat.
- WW Action 9: Promote the use of alternative shoreline protection techniques.
- WW Action 10: Evaluate and improve erosion and sediment control programs to reduce sediment entering salmon-bearing streams.
- WW Action 11: Adopt stormwater standards that protect salmon.
- WW Action 12: Develop programs and protocols for the maintenance of stormwater systems and facilities to reduce entry of sediment to salmon streams.

- WW Action 13: Review road maintenance practices and adopt written operating procedures to reduce potential impacts to salmon and other pollutants and salmon habitat.
- WW Action 14: Review parks and grounds maintenance procedures and adopt written best management practices that protect salmon and salmon habitat.
- WW Action 15: Develop a comprehensive, WRIA-wide process to identify, develop, and prioritize projects that benefit salmon and carry out the WRIA 9 Strategy.
- WW Action 16: Create combined naturalist and stewardship activities across WRIA 9.
- WW Action 17: Encourage the restoration of riparian buffers.
- WW Action 18: Implement Phase 1 of the Ecosystem Restoration Project.
- WW Action 19: Evaluate fish passage barriers at the local jurisdiction level.
- WW Study 1: Monitor habitat restoration projects to determine fish response and apply the information to future projects.
- WW Study 2: Identify which factors are limiting to salmon populations by subwatershed.
- WW Study 3: Develop a research framework for assessing juvenile salmon survival in WRIA 9.
- WW Study 4: Support the Green/Duwamish Water Quality Assessment.
- WW Study 5: Conduct an assessment of large woody debris recruitment in WRIA 9.
- WW Study 6: The WRIA 9 Planning Work Group, WRIA 9 Technical Committee, Central Puget Sound Water Suppliers Forum, and other appropriate agencies should work together to understand and evaluate the water budget for people and fish in the WRIA.
- WW Study 7: Develop mechanisms to increase collaboration and coordination in scientific work directed toward salmon recovery.

Current Efforts

Jurisdiction Efforts

Jurisdictions are working to protect nearshore habitats. The City of Burien uses a binding site plan system that allows flexibility in development design, encouraging low-impact development strategies. Des Moines developed a basin plan for Massey Creek and Barnes Creek to address flooding and regional water quality. Normandy Park has produced a brochure describing how to protect salmon and water quality. SeaTac and King County provide incentives to owners of private stormwater facilities to encourage proper maintenance of these facilities. Federal Way works with staff and contractors to minimize erosion of sediment at construction sites. Seattle has assigned a fisheries biologist to review land use proposals. King County has provided a steward to work with citizens and protect habitats on Vashon/Maury Island. In collaboration with the King Conservation District, the WRIA 9 Forum has sponsored successful nearshore stewardship programs, such as the award-winning Beach Naturalist Program. More information about these activities is in Appendix A.



Projects

This section describes identified projects that should benefit chinook salmon and bull trout, and are planned to start within the next five years. Planned projects that will benefit species other than chinook salmon or bull trout are described in Appendix C.

Jurisdiction Projects

In addition to the programs and policies highlighted above, WRIA 9 jurisdictions plan to conduct projects to protect and improve salmon habitat in the Nearshore subwatershed. Table 31 below briefly describes these plans.

Table 31. Nearshore projects: WRIA jurisdictions.


Project Name and Status	Project Description	Benefit to Salmon	Factors of Decline Addressed	Strategy Elements Addressed	Jurisdiction and Partners
Lincoln Park Beach and Seacrest Park Beach nourishment Status: 	Sand and gravel beach materials were placed over a ½-mile distance in the late 1980s and again in 1994; another nourishment is scheduled in the next few years.	Protects shallow-water habitat for all species	Alteration of habitat-forming process and loss of habitat in migratory corridor	Rehabilitate damaged processes such as sediment transport	Seattle (lead) and the U.S. Army Corps of Engineers
Brown acquisition Status: 	Parcel adjoining Seahurst Park that contains headwaters of the salmon-bearing stream in the park	Protect refuge habitat for all species	Loss of habitat in the migratory corridor	Protect nearshore processes and functions	Burien

Salmon Recovery Funding Board and King Conservation District Projects

WRIA 9 recommends projects for funding to two organizations: the Salmon Recovery Funding Board and the King Conservation District. The Salmon Recovery Funding Board is a state organization that disburses grants for salmon habitat projects. The WRIA 9 Steering Committee selects projects to send to the Salmon Recovery Funding Board for its consideration. Property owners in King County support the King Conservation District with a \$5-per-parcel annual fee. The King Conservation District devotes three-fifths of this fee from parcels within WRIA 9 to salmon, water quality, and flooding projects in WRIA 9. The WRIA 9 Forum approves projects to send to the King Conservation District Board for its consideration for this funding.

One project in the Nearshore subwatershed was submitted for funding in the 2001 Salmon Recovery Funding Board grant process. (In April 2002, the Salmon Recovery Funding Board decided not to fund this project.) Table 32 below describes it briefly.

Table 32. Nearshore project proposed for funding by the Salmon Recovery Funding Board.

Project Name and Status	Project Description	Benefits to Salmon	Factors of Decline Addressed	Strategy Elements Addressed	Funding Source
Branson acquisition Status: 	Acquire 7 acres of nearshore property, with 247 feet of waterfront	Protect rearing and refuge habitat for all species	Loss of habitat in the migratory corridor	Protect unaltered habitat	Salmon Recovery Funding Board (and Washington Wildlife and Recreation Program, Conservation Futures, National Fish and Wildlife Foundation) (not funded)

Studies*Jurisdiction Studies*

Nearshore jurisdictions are collecting data to improve understanding of nearshore habitats and processes. Table 33 below briefly describes these efforts.

Table 33. Nearshore studies: WRIA jurisdictions.

Study Name	Objective	Description	Factor of Decline Addressed	Jurisdiction and Partners
Redondo waterfront study	Determine how best to improve stormwater management	Review boat launch and parking area	Water quality, hydrology, sediment quality	Des Moines Marina Utility
Water quality monitoring	Identify problem areas and trends in water quality	Developed water quality baseline and conducted benthic invertebrate sampling in Des Moines, Massey, Barnes, and McSorley Creeks; additional monitoring to occur every three years	Water quality	City of Des Moines
Water quality and flow data	Identify problem areas and trends in water quality	Collect water quality and flow data at 7 different stations on streams	Water quality, hydrology	City of Federal Way
Macro-invertebrate sampling	Determine stream health	Collect aquatic insects annually at 6 locations throughout city	Water quality, riparian condition	City of Federal Way, Stream Team, and other volunteers
Monitor rainfall data	Determine precipitation trends	Gauges throughout city; sites on web	Hydrology	City of Federal Way

Study Name	Objective	Description	Factor of Decline Addressed	Jurisdiction and Partners
Longfellow Creek Spawning survey	Determine spawning usage of Longfellow Creek by all salmon	Weekly surveys of Longfellow creek during spawning season	Study to fill data gap	City of Seattle
Nearshore fish utilization study	Determine if fish use of the nearshore varies with changes in habitat characteristics	Study now being developed with University of Washington researchers	Habitat alterations	City of Seattle
Pre-spawn mortality study	Determine cause of pre-spawning mortality in coho returning to area creeks	In conjunction with other jurisdictions, Seattle is monitoring the pre-spawning mortality in the City's creeks and providing tissue sample to the state for analysis	Study to fill data gaps	City of Seattle

Salmon Recovery Funding Board and King Conservation District Studies

As described above in the Projects section, WRIA 9 recommends projects for funding to two organizations: the Salmon Recovery Funding Board and the King Conservation District. Because filling data gaps is a high priority for the Nearshore subwatershed, several studies are planned for the nearshore using these funding sources. Table 34 below describes them briefly.

Table 34. Nearshore studies: Salmon Recovery Funding Board and the King Conservation District.

Study Name	Objective	Description	Factors of Decline Addressed	Funding Source
Seahurst Park Seawall	Determine best alternative to existing seawall	Study of options for removing the seawall in Seahurst Park while protecting recreation and enhancing marine riparian vegetation	Alteration of habitat-forming processes	Salmon Recovery Funding Board
Beach seining	Determine timing of juvenile migration through nearshore	Use seine nets to capture juvenile salmon	Study to fill data gaps	King Conservation District
Puget Sound Nearshore Ecosystem Restoration Project, Phase 1	Develop list of nearshore restoration projects	This Sound-wide program will develop an ecosystem model, fill data gaps, develop criteria, and identify projects	All nearshore factors of decline	King Conservation District (and the U.S. Army Corps of Engineers and a multitude of local sponsors)

